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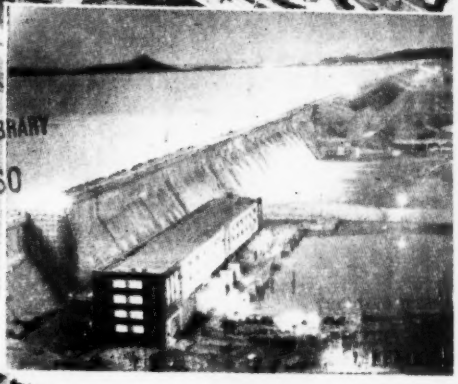

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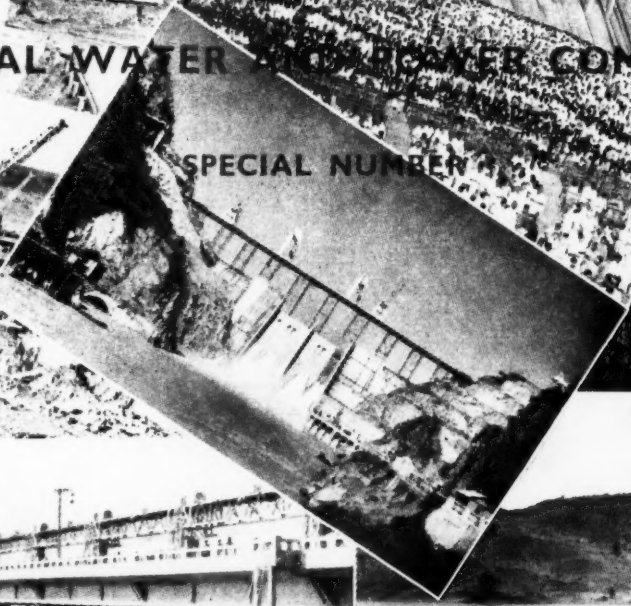

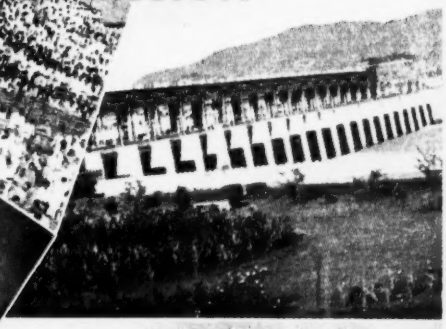

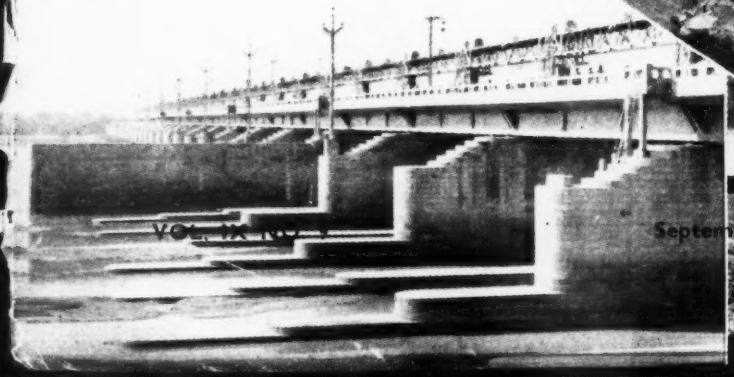

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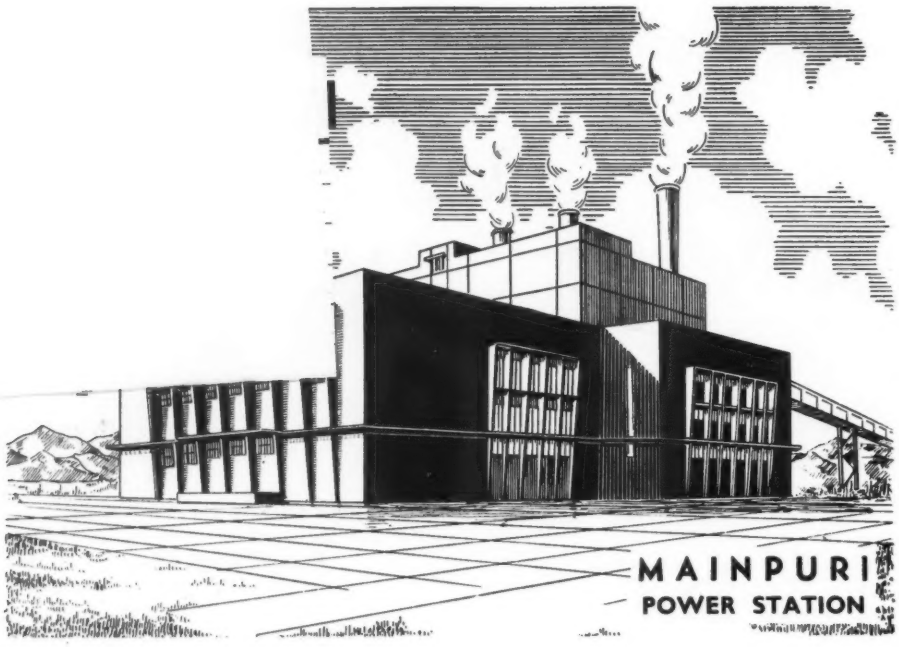

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An order worth nearly £5 million is being placed with AEI for two 300,000 kw. turbine generator units which will be installed at West Thurrock power station, near Tilbury. Each of these generators will have the greatest single-shaft output at 3,000 r.p.m. in the world, each will, in fact, be capable of generating 2,628 million units in a year.

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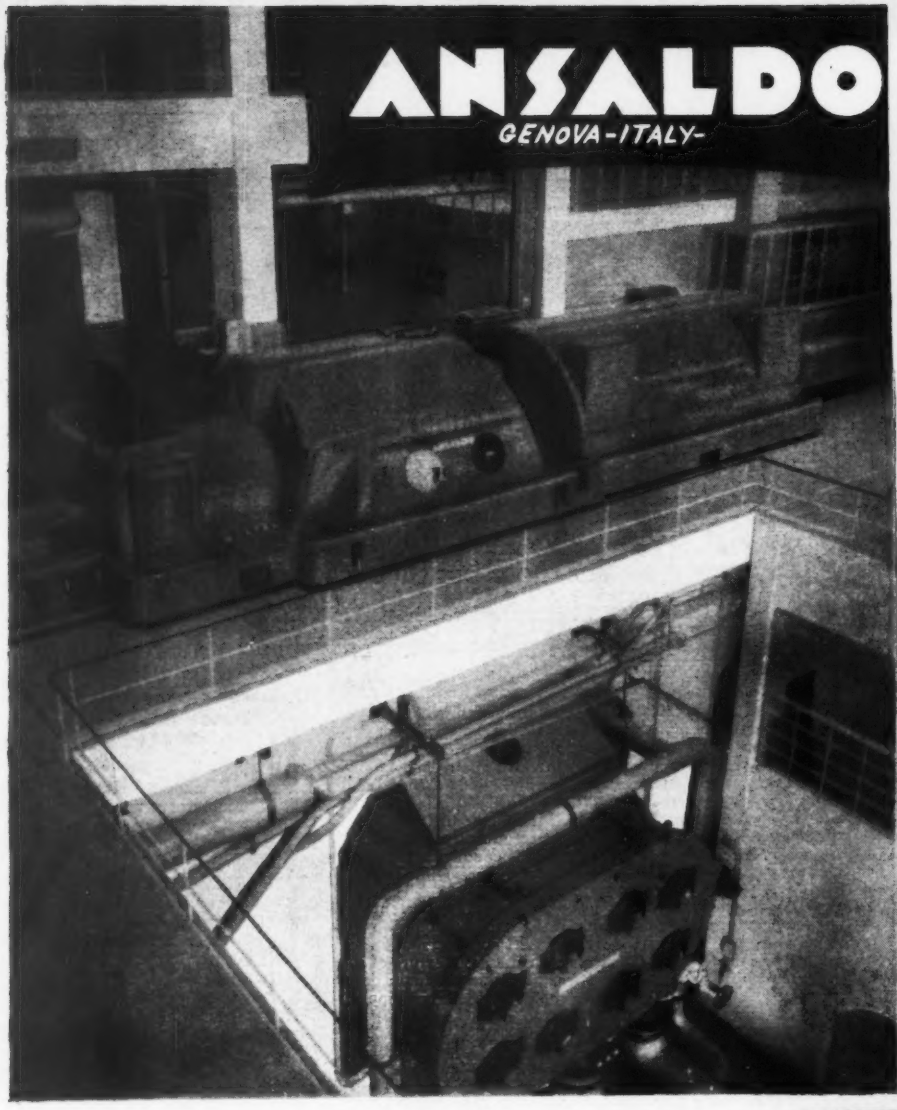

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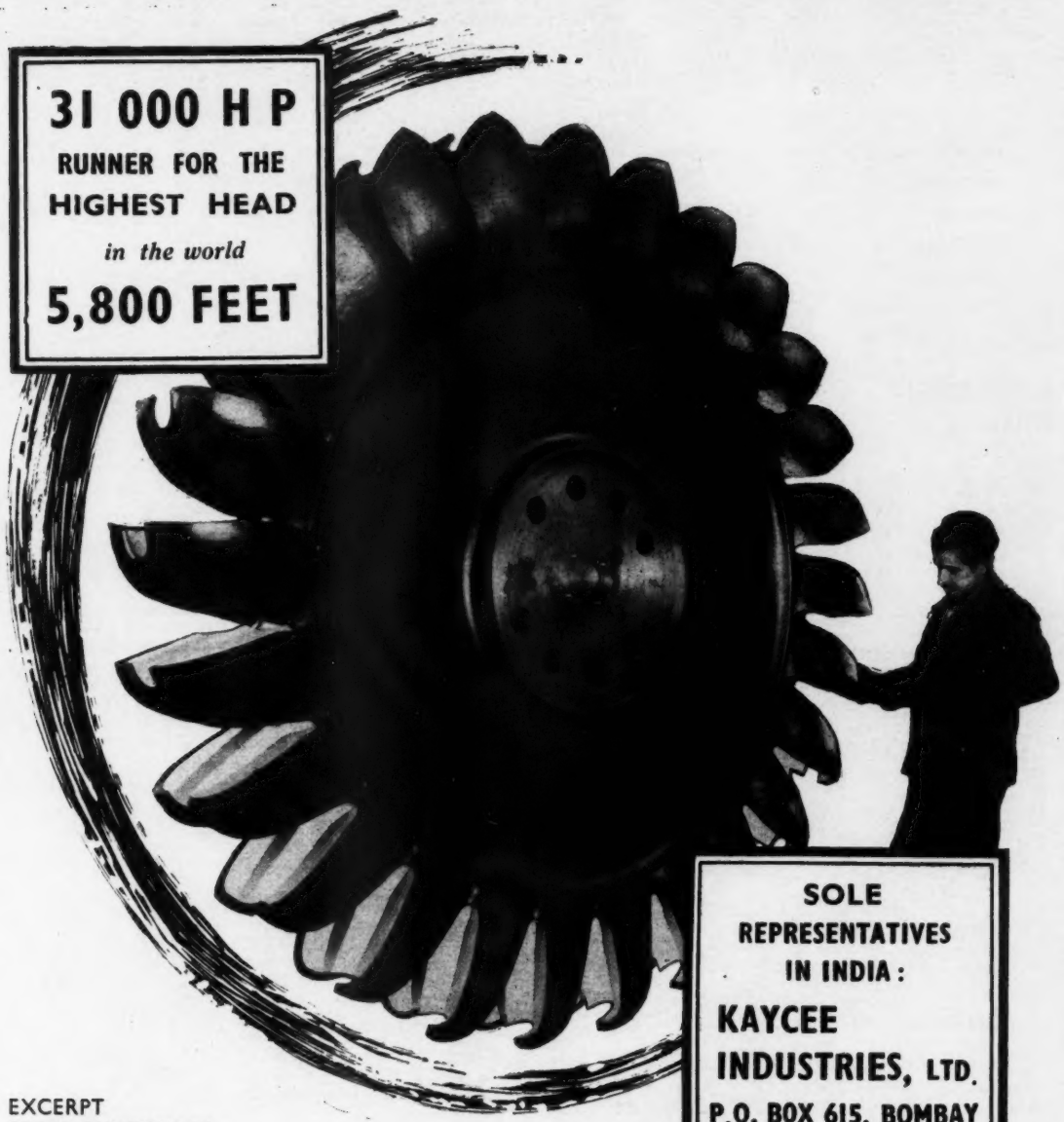

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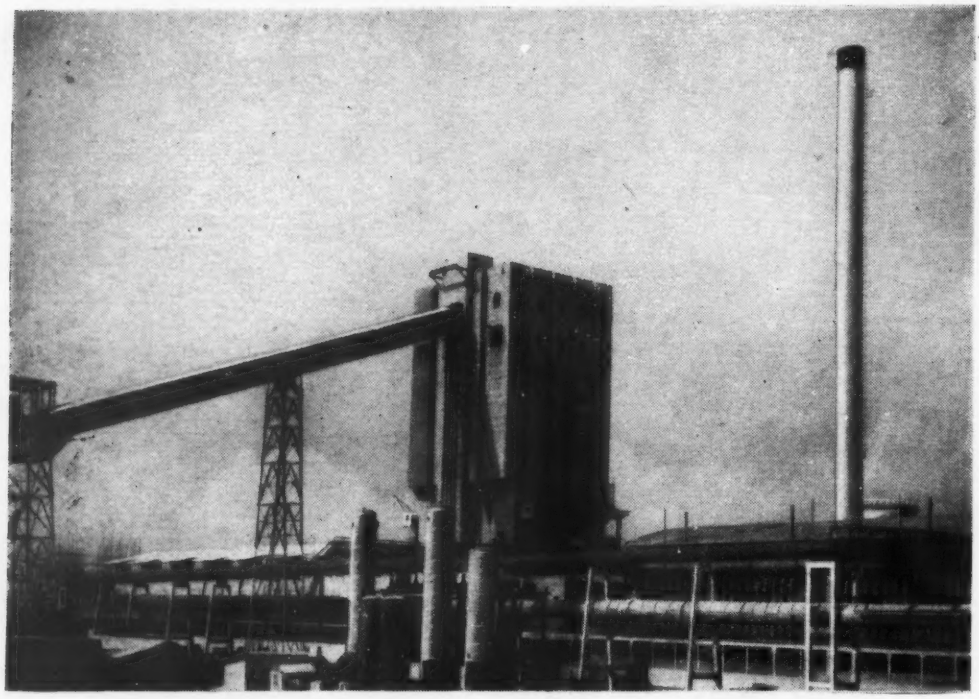

The lighting-up of the Coke Oven battery No. 1 marks a new stage in the progress of the Durgapur steelworks With the lighting-up of the Coke Oven battery No. 1 on 24th August, the Durgapur steelworks of Hindustan Steel Limited enters a new stage. ISCON is proud to announce that work on this battery has been completed nearly ten weeks ahead of schedule. When the process of gradually heating up the battery to operating temperature is completed, the Coke Ovens will be ready to supply coke for the first blast furnace to produce Durgapur's first pig iron.

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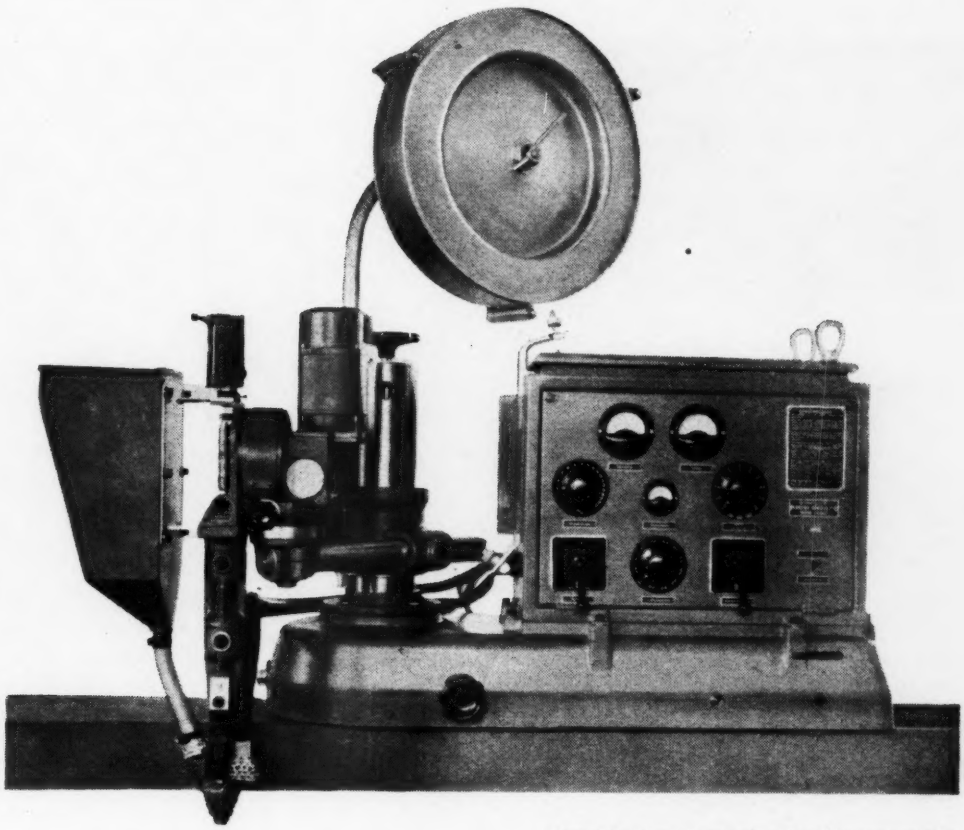

Head of the Brown Boveri automatic welder ; note reel that carries electrode material. A motor-generator welding set completes the equipment

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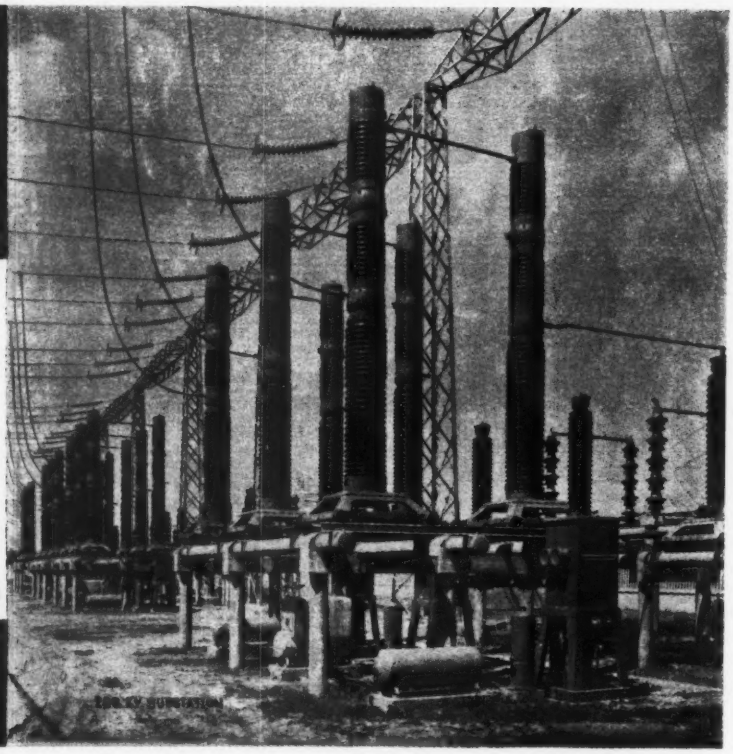

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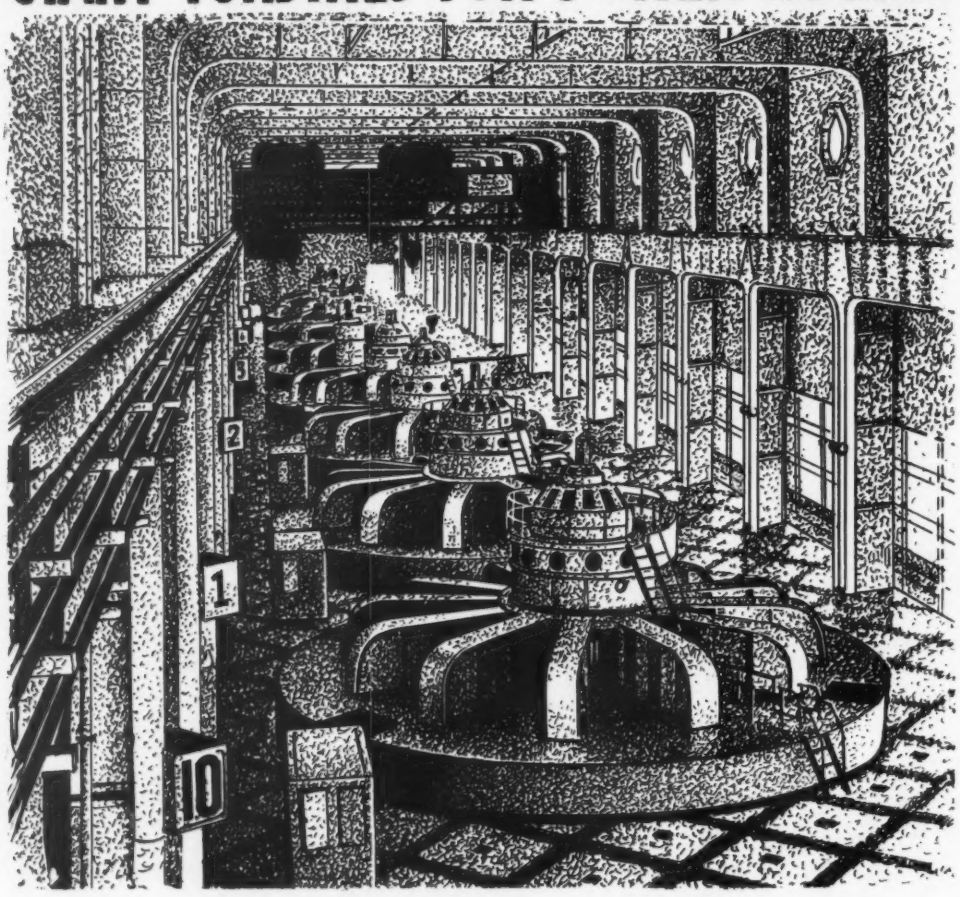

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The world's most efficient turbine-generator is also being built by Westinghouse. It is a 325-mw cross-compound unit soon to go into operation for the Philadelphia Electric Company at the highest steam pressure and temperature in history—5,000 psi and 1,200° F.

Westinghouse is looking ahead to *tomorrow's* power demands, too—through continued research and development that will permit construction of still larger and more efficient power plants. For example, Westinghouse engineers are now evaluating a new alloy that has the phenomenal tensile strength of 100,000 psi at 1,200° F.

A $25 million program is now under way to expand and modernize Westinghouse facilities for the production of power generating equipment. At the heart of this program is a new engineering concept—the development of "pre-engineered" basic components for steam turbines. These parts can be manufactured in many duplicate sets and assembled like building blocks in almost any combination, greatly improving manufacturing efficiency and lowering costs.

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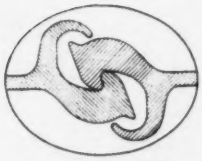

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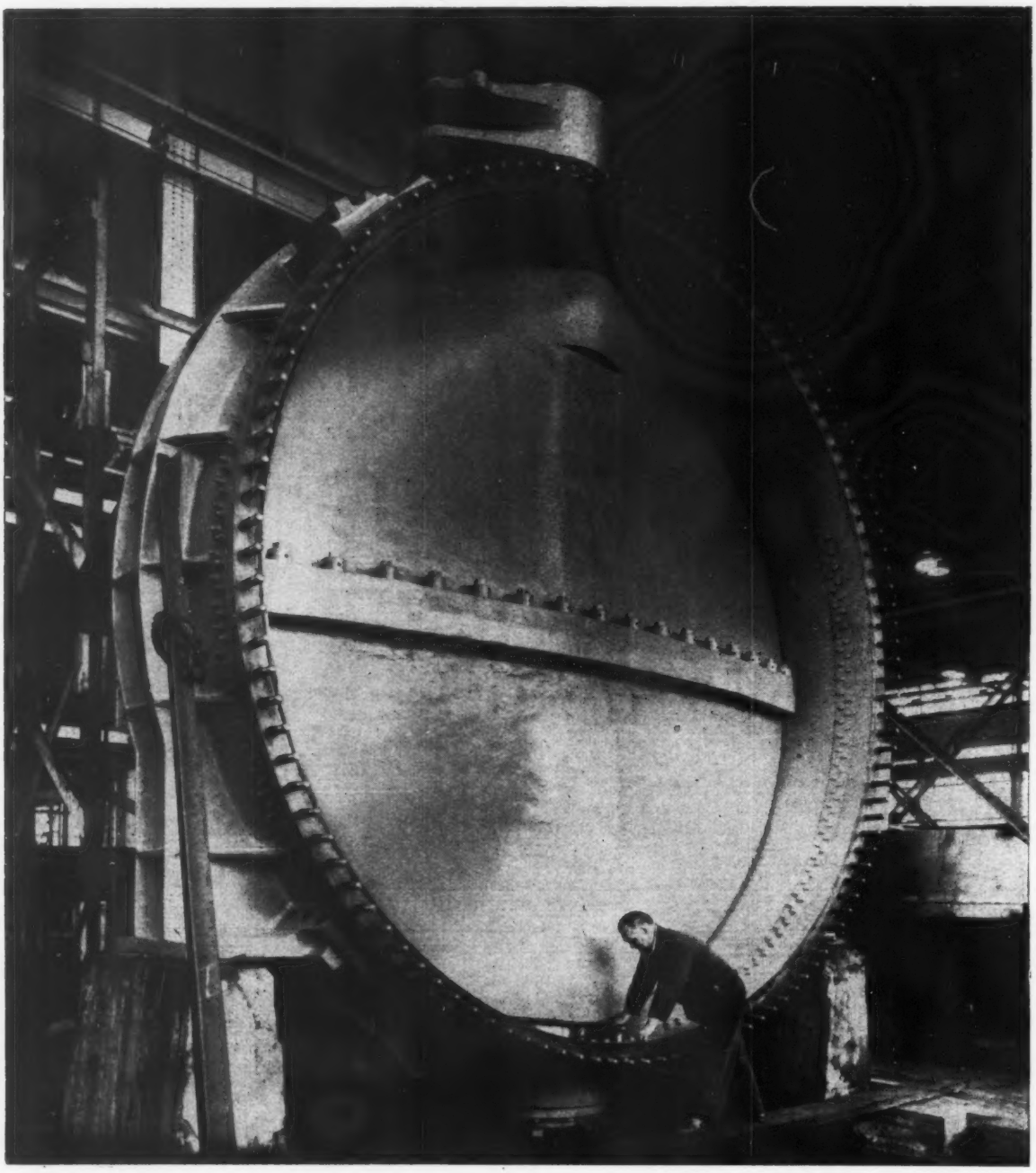

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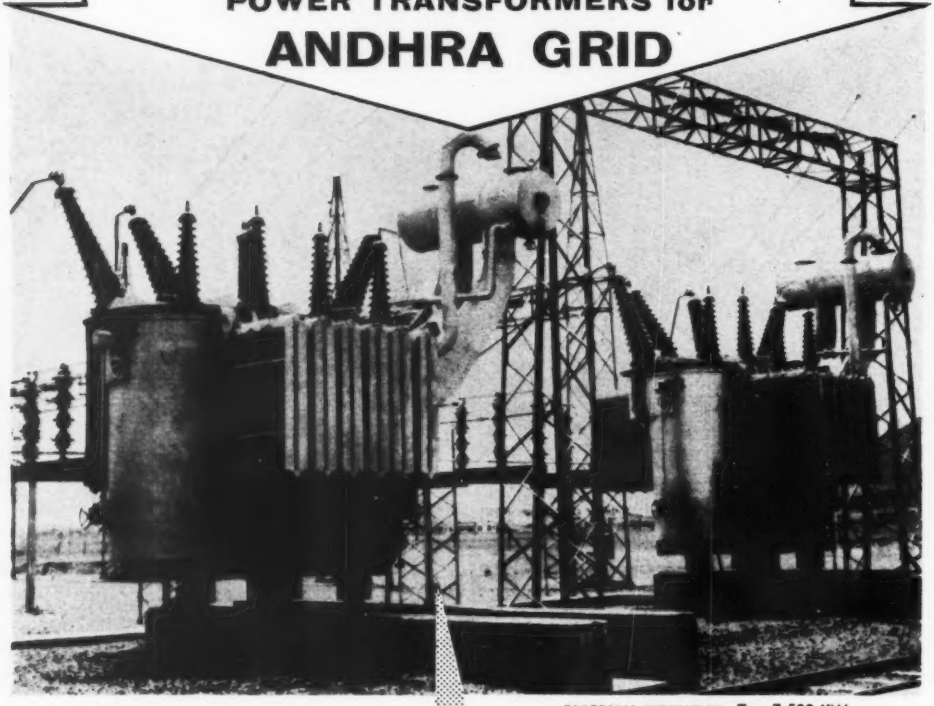

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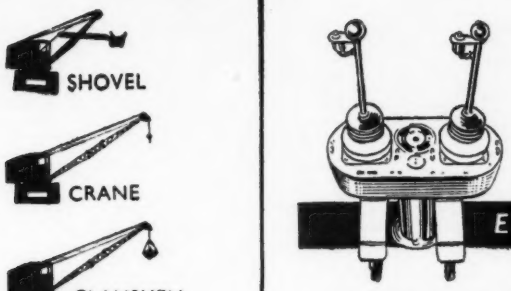

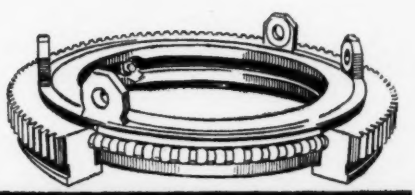

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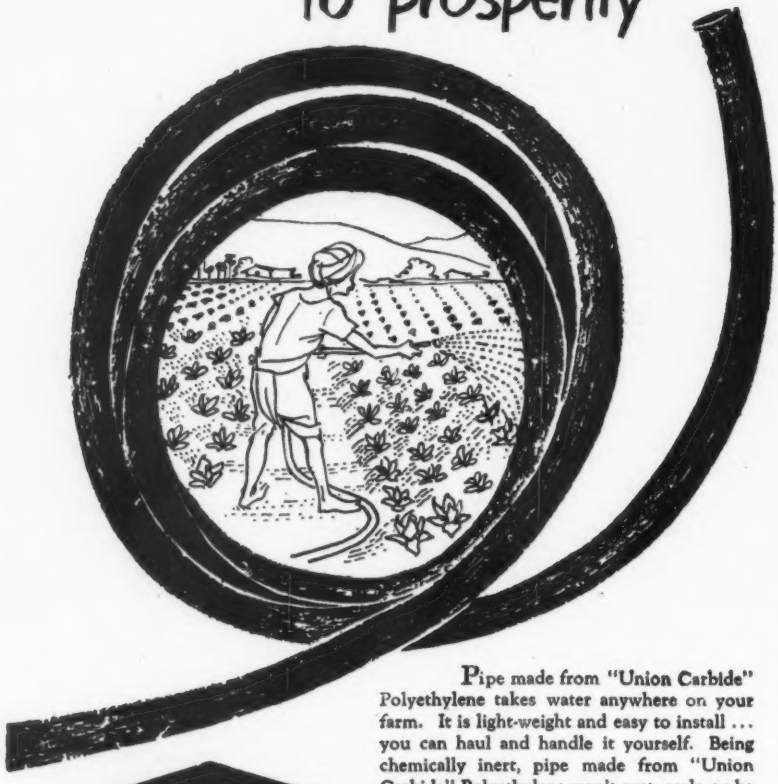

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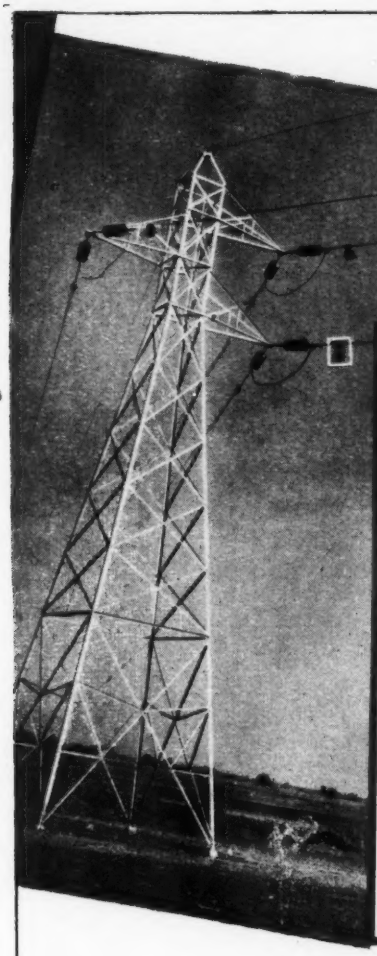

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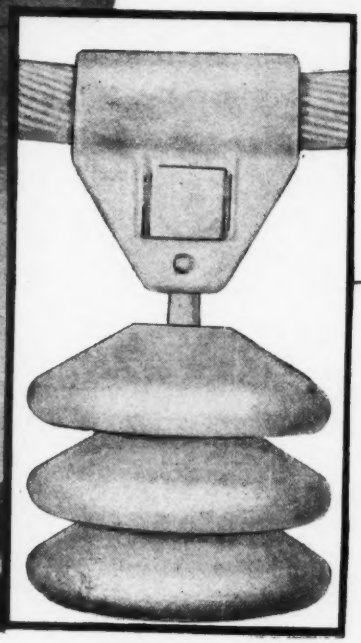

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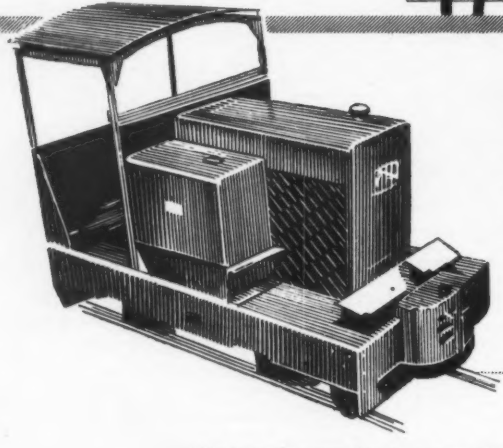

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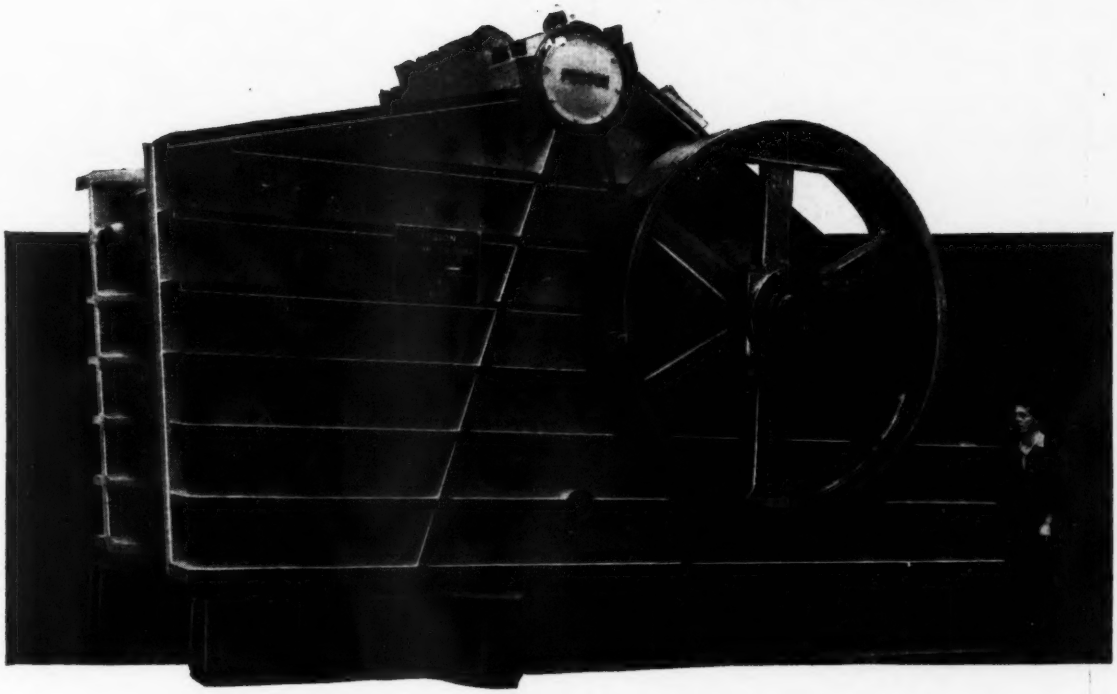

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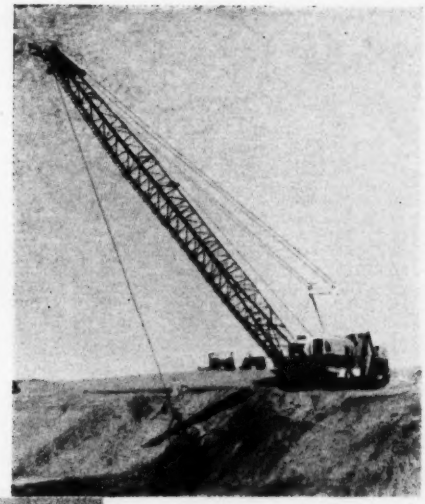

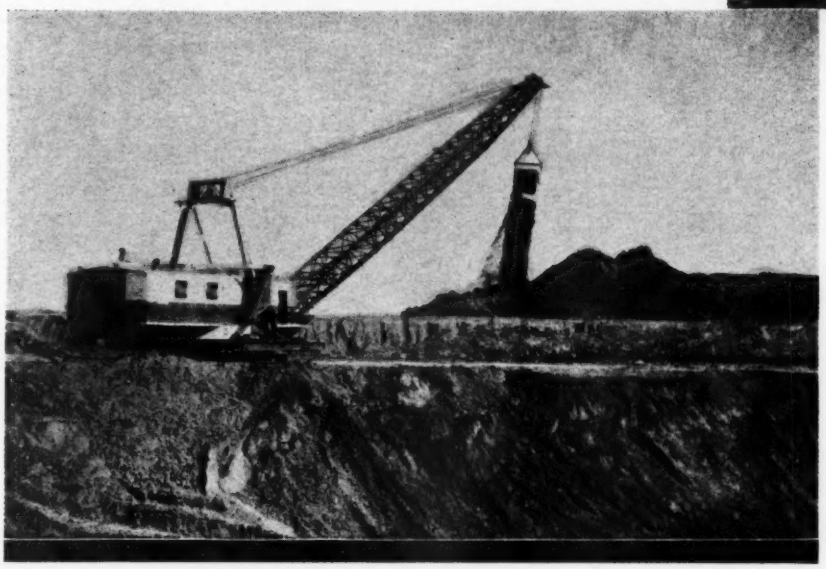

CLEANING OUT THE BOTTOM OF THE CANAL. Both the Superintending Engineer of the Project and the Assistant Engineer in charge of the draglines state that Marions are "first class pieces of equipment". The machines were sent to India under the Technical Cooperation Mission Program.

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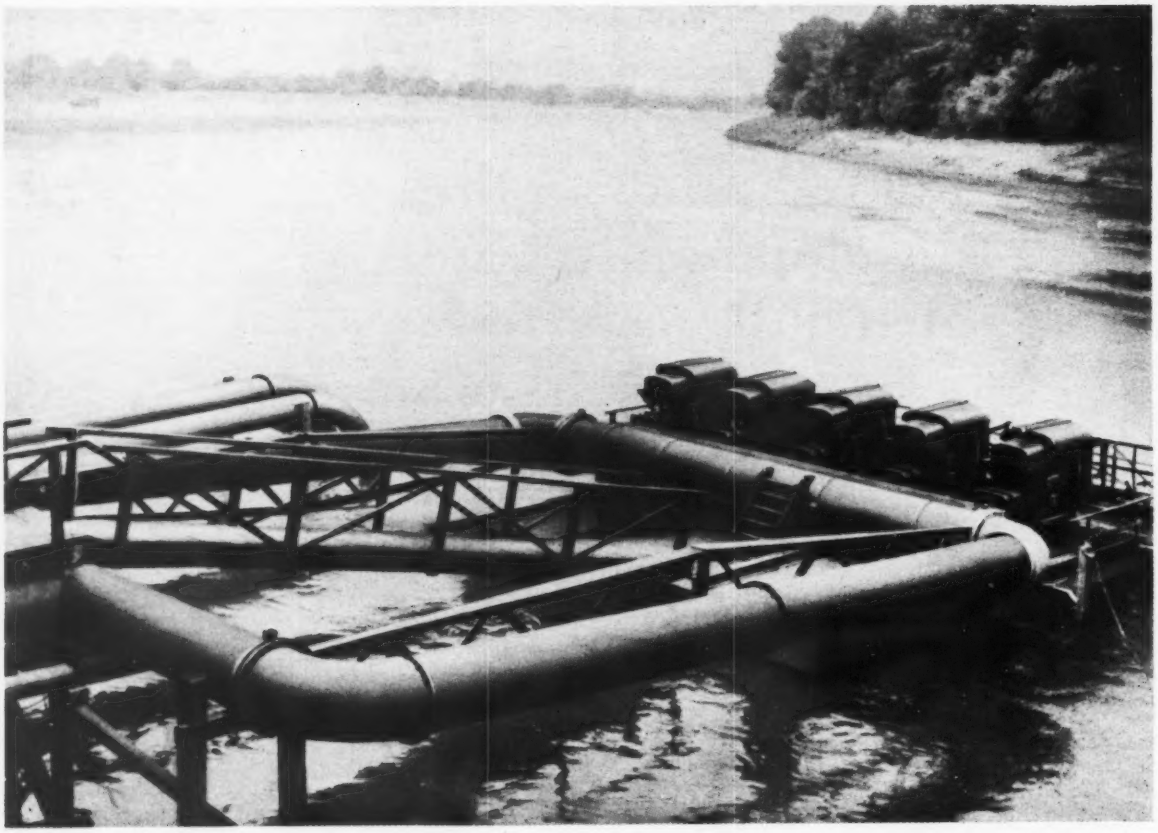

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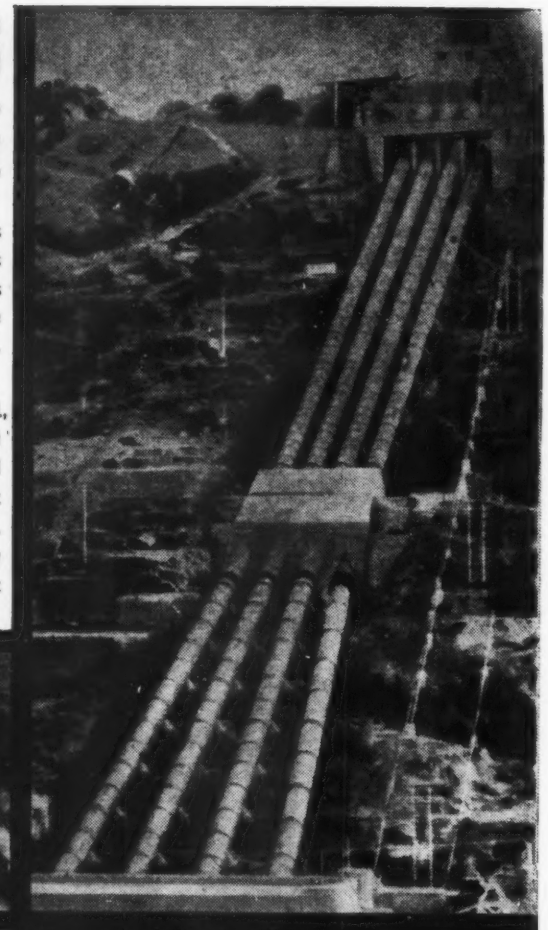

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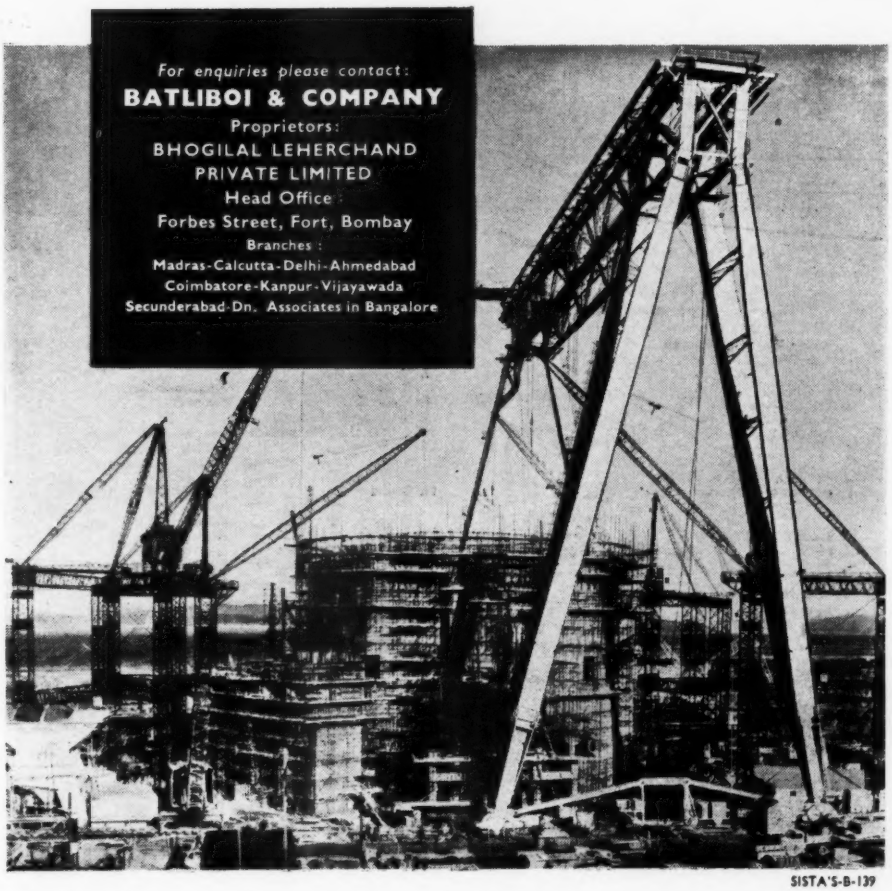

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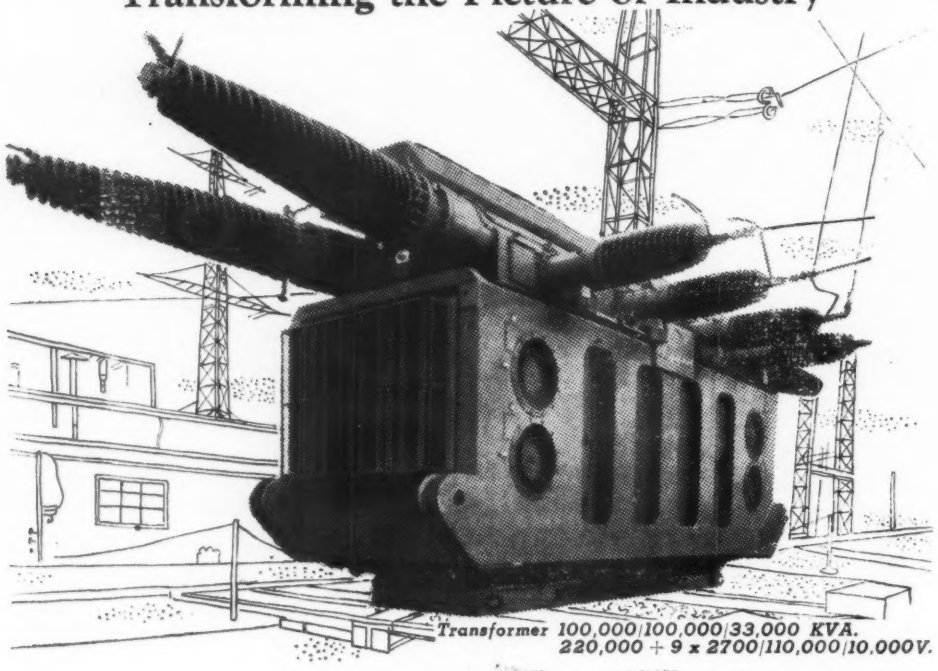

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A MONTHLY DEVOTED TO DEVELOPMENT OF POWER & WATER RESOURCES IN ASIA

Editor : K. K. Sinha — P. K. Menon : Mg. Editor

VOL. IX — SEPTEMBER 1959 — NO 9

CENTRAL WATER AND POWER COMMISSION SPECIAL NUMBER

CONTENTS

MESSAGES		xxxvii
INTRODUCTION		xliii
ROLE OF CENTRAL WATER AND POWER COMMISSION IN THE FIELD OF POWER TRANSMISSION	*M. Hayath and V. Venugopalan*	1
DEVELOPMENT OF A PORT ON THE MAHANADI MOUTH AT PARADIP	*Yadava Mohan*	5
ROLE OF CENTRAL WATER AND POWER COMMISSION IN THE PROGRESS OF RURAL ELECTRIFICATION	*S.S. Kumar and A.P. Seethapathy*	9
WORKING OF THE SILT AND CONSTRUCTION MATERIAL DIRECTORATE	*R. C. Hoon*	13
SUB-SURFACE DRAINAGE AND IRRIGATION : TREND IN EAST EUROPEAN COUNTRIES	*R. D. Dhir*	17
A SAMPLING APPROACH TO THE ESTIMATION OF FLOODS	*P. R. Ahuja and K.C. Majumdar*	23
A SURVEY OF PRESENT AND FUTURE POWER DEMANDS OF INDIA	*A. Shankaran*	29
OUR SCHOOLS FOR TRAINING IN EARTH-MOVING MACHINERY	*J. E. Vaz*	35
CONSTITUTION, FUNCTIONS AND WORKING OF THE CANALS DIRECTORATE	*S. Raghavachari*	37
CENTRAL WATER AND POWER RESEARCH STATION	*S. L. Banerjee*	40
TECHNICAL SCRUTINY OF IRRIGATION PROJECTS	*K. B. Khushalani*	41
ORGANISATIONAL SET-UP OF THE CENTRAL WATER AND POWER COMMISSION	*K. C. Khatri*	45
TECHNICAL NOTES AND NEWS		51
OUR CONTRIBUTORS		63
Index to Advertisers		66

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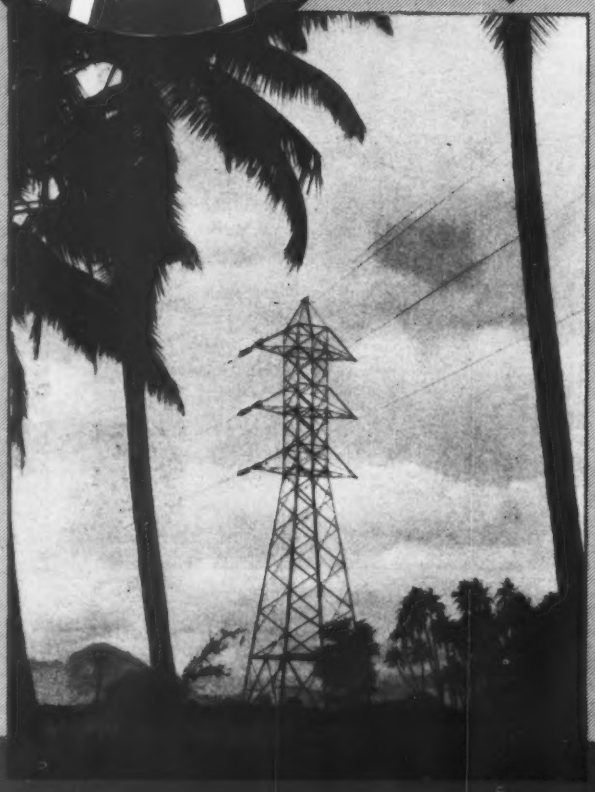

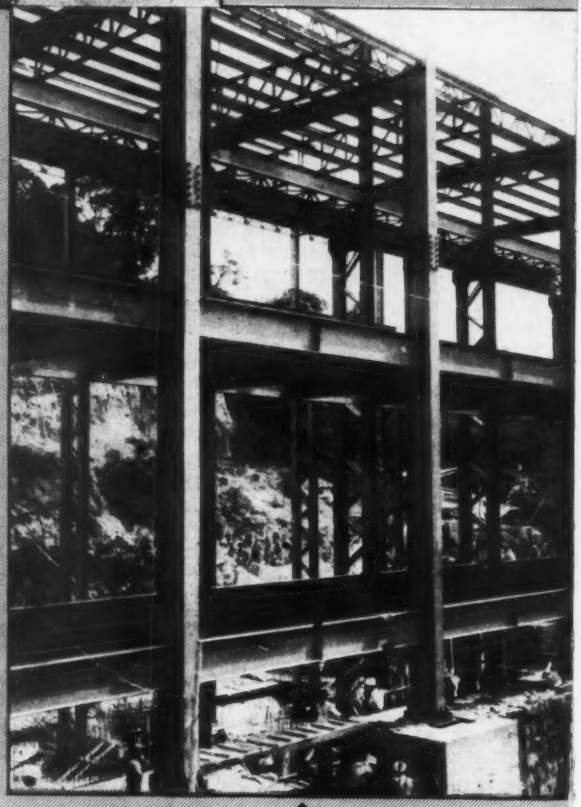

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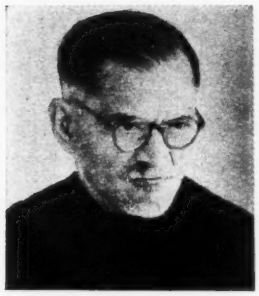
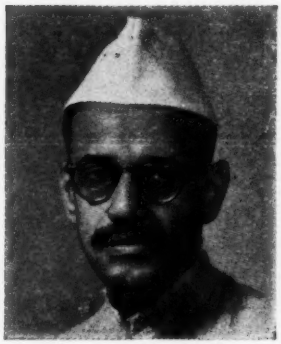


That a journal of the standing of the Indian Journal of Power & River Valley Development should have decided to bring out a special issue, devoted principally to the activities of the Central Water and Power Commission, is at once a recognition of the importance of the role which the Commission is playing in the examination and planning of irrigation and power projects and proof of the deep interest the journal has been taking in keeping the general public informed of the progress which we have been making in what is without doubt the most vital sector of our national economy—a sector which seeks to provide water to augment food production and power to develop our industries.

HAFIZ MOHD. IBRAHIM
Minister for Irrigation and Power
Government of India



I am glad that the Indian Journal of Power and River Valley Development is bringing out again, after a lapse of five years, a special number devoted to the activities of the Central Water and Power Commission. India has yet to make considerable leeway in order to come abreast with the advanced countries of the world. The country has to make bigger and more rapid strides in the coming years towards its development and in this irrigation and power have to make a major contribution. The Central Water and Power Commission plays an important role in the development of power in the country and in harnessing its water resources. This organisation with which I was connected for some years has grown from strength to strength and will, I trust, continue to render valuable service to the country.

I wish the journal all success in its task and wish it increassing opportunities for its work.

G. L. NANDA
Minister for Planning, Government of India

I am glad to know that the Indian Journal of Power and River Valley Development of Calcutta is bringing out a special number devoted to the activities of the Central Water and Power Commission. I send my good wishes for the success of the publication.

S. K. PATIL
Minister for Food and Agriculture
Government of India

I am glad you are bringing out a special number devoted to irrigation and power and the activities of the Central Water and Power Commission. The subjects proposed to be dealt with are very important and the articles will prove useful to all those who are engaged in planning and carrying out our projects.

V. T. KRISHNAMACHARI
Deputy Chairman, Planning Commission

I am happy to learn that the Indian Journal of Power and River Valley Development is bringing out a Special Number devoted to the Central Water and Power Commission. This is the second CW&PC Number, the first having been published in 1954. In the normal history of a large national organisation, a few years is perhaps a short period. But it is the law of nature that growth in infancy is marked and rapid, which is no less true of organisations with an inherent constructive potential.

The Central Water and Power Commission was established in India in 1945 as a central fact-finding, planning and co-ordinating organisation. It has now become, truly, a central organisation, which appraises the country's resources of water and power, and recommends plans for their development with a view to derivation of the maximum benefit to the nation as a whole. The new activities associated with flood control in the affected States and the investigation and assessment of the irrigation and power potential of the various river valleys in the country, that have been added to the Commission's functions, constitute further landmarks in the growth and utility of the CW & PC. The special issue will, I hope, give some idea of the scope of the CW & PC's functions and the manner in which the objectives set before it are being implemented.

I wish the Indian Journal of Power and River Valley Development success in its endeavour to keep the public informed of India's aims and achievements in the field of water and power resources development.

JAISUKHLAL HATHI
Deputy Minister for Irrigation and Power
Government of India

I am glad that the Indian Journal of Power and River Valley Development is bringing out a special issue on the activities of the Central Water and Power Commission. I am sure that this issue will be helpful in educating the general public about the various Power and River Valley Projects that have been sponsored by the Commission.

B. C. ROY
Chief Minister, Government of West Bengal

I am very glad to learn that the Indian Journal of Power and River Valley Development is bringing out a Special Number devoted to the activities of the Central Water and Power Commission.

The importance of orderly and swift development of Irrigation and Power in our country in its march of economic progress hardly needs any emphasis. While the development of water resources in their respective regions are principally to be carried out by the different State Governments, since the larger river basins extend over several States, co-ordinated planning of the utilization of water resources of such river basins becomes essential. The Central Water and Power Commission is the highest technical authority under the Centre in these matters and the co-ordinated and orderly exploitation of irrigation and power resources in the different States can only be brought about if the Central Water and Power Commission plays a role appropriate to its high responsibilities. I therefore welcome your enterprise in bringing out this Special Number which ought to help bring out such a consummation by promoting an informed discussion of the organisation, functions and instrumentalities of the Central Water and Power Commission. I have pleasure in welcoming your Special Number.

Y. B. CHAVAN
Chief Minister, Government of Bombay

I am very much pleased to learn that you propose bringing out a special number of 'Indian Journal of Power and River Valley Development' featuring the activities of the Central Water and Power Commission.

Irrigation and Power are the mainstay of increase in agricultural output leading to self-sufficiency in food. That the problem of food must receive top priority is undisputed, and, having realised this, our leaders have projected the food front and formulated its plan of action. Befitting its self-imposed task, your Magazine should provide a forum for this vital topic of the day — *all-round help to grow more food.*

The list of the contributions to this number outlines the pen-portraits of the potentials, demand and supply of Water and Power in various parts of India as also of the destined role of Central Water and Power Commission in the utilization of these natural resources for the service of our people.

Hoping your Journal would fulfil the aspirations of the Commission, I welcome its advent and also wish you success in your purposeful venture.

B. D. JATTI
Chief Minister, Government of Mysore

I was glad to learn about the forthcoming Special Number of your Journal devoted to the activities of the Central Water and Power Commission. I am sure that the Special Number will help its readers to acquaint themselves with the activities of an organisation which is carrying out tasks which are extremely important for the nation as a whole.

E. M. S. NAMBOODIRIPAD
Ex-Chief Minister, Government of Kerala

I am delighted to know that the Indian Journal of Power and River Valley Development is contemplating to bring out a special number devoted to the activities of the Central Water and Power Commission. I have seen the list of contents and the names of the luminaries who have agreed to contribute. In the context of modern development, technical knowledge of the activities of Water and Power Commission made available in simple language by the authorities on the subject is a very welcome thing. India needs to develop her immense water and power resources before we can think of beating back the oninous shadows of poverty and squalor. Self-sufficiency in the matter of food-grains is the sheet-anchor of all development, though to be able to play a rightful role in the comity of civilised nations we cannot afford to lag behind in the industrial field as well. Development of cheap power is the key to all problems.

I have, therefore, to congratulate you on the venture you are making in bringing out this issue which in my opinion will go along way in the reassessment of our water and power resources and place in a proper perspective the benefits we are going to derive from them.

PARTAP SINGH

Chief Minister, Government of Punjab

The Indian Journal of Power and River Valley Development has rendered valuable service to the profession and the country in placing before the public lucid and well illustrated account of the up-to-date progress and special features of the River Valley Projects in India and allied developments in other countries of the world. Professional engineers, both beginners and those of high standing as well as the general public have derived great benefit from this Journal.

The Central Water and Power Commission has been charged with the general responsibility of initiating, coordinating and furthering, in consultation with the State Governments concerned, schemes for the control, conservation and utilisation of water resources throughout the country for purposes of flood control, irrigation, navigation and water power generation as well as the schemes of thermal power development and also schemes of transmission and utilisation of electric energy throughout the country. It is in the fitness of things that this Journal has brought out a special issue on the Central Water and Power Commission, for in dealing with the activities of that Commission, it will be dealing with the development of the basic resource of the country, namely, water, on which depends the development, among other essentials, of agriculture and power, and therefore of industry and all that contributes to increasing the wealth of the country and the raising of standard of living of the people. In chronicling the activities of this organization, it will be laying before the public what has been achieved in the field of water resources development to date and what remains yet to be achieved.

I congratulate the management of this Journal on the excellence of content and presentation of this publication.

A. N. KHOSLA

Vice Chancellor, Roorkee University

I am so happy to learn that the Power and River Valley Development Journal is bringing out another special number devoted to the activities of the Central Water and Power Commission. The first special number was issued by them about five years ago. During this interval, when I happened to be the Chairman of the Central Water and Power Commission, the activities of the Commission expanded considerably. In a democratic set-up it is necessary that the people, for whom the Central Water and Power Commission exists, are acquainted with its expanded activities.

Water has always been a governing factor of all human existence and activities. History has provided innumerable examples to show that Nations flourished where abundant supply of water was assured. A report in the 'Scientific American' for January, 1956 says "many have gone without food for well over 30 days....but a man in a hot desert without water may be brought within the grasp of death in a few hours".

Most of the countries, particularly under-developed countries, with their primary dependance on agriculture have undertaken large-scale conservation and development of their water resources. No other single factor can help to meet the growing demands for food of the country than making water available when it is needed by the crops.

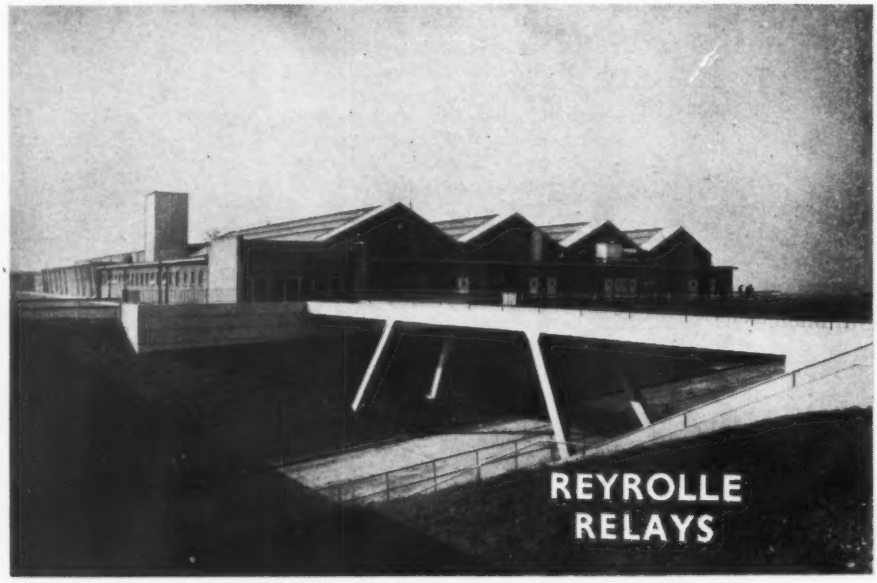
Industrial advancement hinges on the availability of cheap and abundant power. This can be made available by tapping hydro potential of the country. It is sometimes not fully realised that generation of power from coal, oil or nuclear resources consumes the actual resource which ultimately must come to an end. On the other hand, the hydro power potential is replenished by natural phenomena every year and there is no fear of this resource being ever exhausted. In view of this, hydro power will always play a very important role in providing cheap power at all times.

River and river basins do not conform to man-made boundaries. For the optimum overall development of a river basin unified development is of the utmost importance. There should be no waste of any possible potential due to regional considerations.

Co-ordinated development of the water resources of a river will demand that all specialist groups should plan with the same perspective and fit their work into a common endeavour. All efforts to distort planning amongst different users of water must be prevented. There must be a common vision and a common purpose in evolving integrated Master plans and in implementing them. This is what the Central Water and Power Commission does.

I may express my considered opinion that but for the Central Water and Power Commission the development of the water resources of the country would not have been possible at the pace at which it has been achieved in the First and the Second Five Year Plans. There is need to strengthen the Central Water and Power Commission in the interest of the Nation.

KANWAR SAIN
Chairman, Rajasthan Canal Board and ex-Chairman, Central Water and Power Commission



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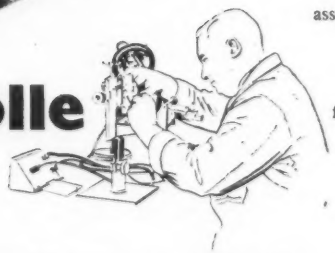

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INTRODUCTION

Since the attainment of independence the Government of India laid considerable stress on the development of irrigation and electricity. River valley projects like the Damodar Valley, Bhakra, Hirakud, Tungabhadra, Koyna, Kosi, Nagarjunasagar, Saravathy have become a part of the vocabulary of India's progress. The first and the second Five-Year Plans have invested Rs. 585 crores and Rs. 817 crores respectively towards irrigation and power programmes which form quite a sizeable fraction of the total in each Plan.

Retrospectively viewed, this emphasis appears to have been justified, although one may disagree on details. As a matter of fact in a developing economy such as that of India's this emphasis needs to be carried over to future years. Power is a pre-requisite to industrial development. And irrigation is an essential element in increasing agricultural production.

India has 485 million acres as culturable area, the net sown area being 293. Of these not more than 82·5 million acres will be irrigated by 1961. This gives an idea of the tremendous leeway still to be covered.

Similarly by 1961 India would have not more than 6·4 million kW of installed capacity. This is indeed far below a decent standard. If the pace of industrial development is not to be hindered, we would need *at the least* 50 million kW by 1985.

Thus it is easily seen that there can be no question of slowing down the pace in either fields. The only point is how these basic tasks can be accomplished.

So far the Ministry of Irrigation and Power and the Central Water and Power Commission and its predecessors have done tremendous work, some idea of which can be gathered from the following articles. What is now necessary is to reappraise the organisational position and to see whether any improvement is needed in order to discharge the task competently. A committee with Sri B. K. Gokhale as Chairman has gone into the matter and is reported to have submitted its Recommendations which are not yet public. We are therefore obliged to offer our approach to the question in ignorance of these recommendations. But in a way this may turn out to be useful inasmuch as the same question would be examined from an independent angle.

After very careful consideration of the matter we have come to the conclusion that a stage has now been reached when the country needs a Ministry of Fuel and Power and a Ministry of Water Development.

In view of the programme of rapid industrial development, planning for power from *all* sources in an integrated pattern and with a definite *perspective* in mind has become all-important today. If the recent discussions among our experts on this issue is carefully followed, it will be apparent that the situation is not quite satisfactory. Atomic, Thermal, Hydro and Diesel sources are being looked after by different ministries. These may have historical justifications. But if we realise that each of these sources has their own limitations and that their development has to be integrated into a harmonious plan consistent with a long-term perspective, and if we further remember that the programme of development to be undertaken is truly tremendous (about ten times) compared to what we handle now, there will be little difficulty in appreciating that the organisation that will plan, technically scrutinise, supervise and coordinate the execution of these projects should be centralised into one agency and that it should be left to concentrate on the job without other distractions. In other words, a Ministry of Fuel and Power will look after generation of power from atomic, thermal, oil and hydro resources, and its transmission and distribution. It may be assisted by an expert body such as, say, a Fuel and Power Board, flanked by functional Directorates and the eight Zonal Commissions. This is not only a big enough job. In view of the new factor of nuclear power which is bound to play an increasingly significant role in India's Power programme, and in view of the limited power potential from other sources compared to the huge requirement in another quarter of a century, the job is also extremely important and onerous.

Similarly the demand on water is growing both in quantity and variety of purposes. Although India is a country of rivers and only 5.6% of its run off is being utilised, what is more important is to plan from now on an integrated *basinwise* development of the rivers. Thus a Ministry of Water Development will have to deal with irrigation, flood control, domestic and municipal needs, industrial water requirements, waterlogging and drainage, groundwater problems, silt control, inland navigation planning, etc. In other words, it has to consider an all-round development of our river and water resources. Already the country has been divided into River Commissions and valuable work is being done by these. It may be useful if such a proposed Ministry is helped by a Water Development Board which in its turn is aided by these River Commissions, apart from other specialised Directorates.

The major item of hydro-power will be of common concern to both the ministries and will thus need coordinated action. But as power planning and its technical supervision needs to be centralised, hydro power should be of major concern to the Ministry of Power.

It may also be noted that development of power is closely related to industrial expansion, and irrigation and river development are more related to agriculture and food production. Would it therefore not be better if these two functions are more closely related to the two respective sectors of our national economy? In this connexion mention may be made of our recent experience of the non-utilisation of the full potential of available irrigation waters. These problems may be avoided in the future if, for example, there is closer coordination between those who plan and execute irrigation projects and those who look after agriculture and food production and community development.

Our country is politically constituted on federal lines, which means that the actual centre of gravity of political power resides in the States, not at the Centre. Both irrigation and electricity are State subjects. But the sources of power are unevenly distributed, and development of river waters passing through 'successive' States needs to be planned ahead for optimum utilisation.

Thus a central agency for advance planning, technical examination, coordination and evaluation is a necessity. Since the idea of national planning has already taken root and a Planning Commission performs the necessary function, it needs a suitable expert body for each field to assist it in both planning and technical supervision. Quite a substantial experience has been gained so far in this respect and it is time that, in harmony with the new and enlarged tasks facing us, our administrative and expert bodies are suitably streamlined, so that unnecessary duplication of effort or lack of coordination at the top is minimised. There are ample centrifugal forces operating at the base. Lack of unified organisational leadership at the top will further cause delay and affect the efficiency of performance. Rapid development of resources which are unevenly distributed makes it imperative that serious attention be paid to this problem now than at a later date.

It is heartening to know that the Planning Commission is giving increasing attention to perspective planning. As we have expressed on an earlier occasion, this is a vital task. While political administration is based on States, nationwide resource development planning would naturally be based on resource situations and latest technological methods. The Central leadership has therefore to evolve suitable organisational mechanisms for its operation that would harmonise Statewise endeavour with optimum resource development plans. It is in this perspective that we have sought to heighten the importance of power zones and regional river commissions.

These are some of the thoughts that occur to us as we review the work of the Central Water and Power Commission in this special issue and we offer these tentative proposals for consideration by all concerned.

In publishing this special issue devoted to the activities of the Central Water and Power Commission we thankfully acknowledge the cooperation of the Commission without which it may not have been possible to present this rich material.

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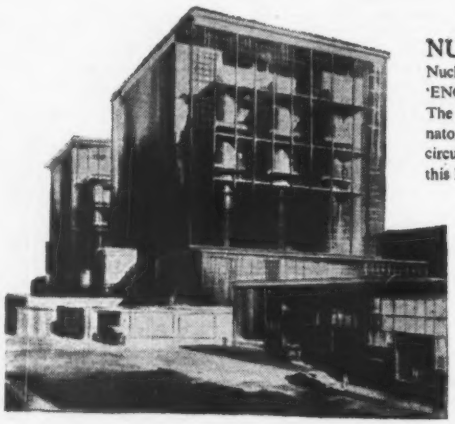

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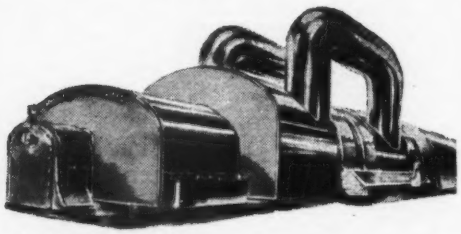

STEAM. One of five 200 MW Steam Turbo-Alternators which the Company is supplying for the High Marnham Power Station, U. K. Early this year the Company received an order for two 275 MW Steam Turbo-Alternators for the New Blyth Power Station, U. K., and the sets are the two largest in-line turbo-alternators of their kind (50 cycles) in the world.

HYDRO. One of two 37.5 MW Water Turbine Generating Sets installed at Hirakud Power Station, Orissa. In the past 10 years the Company has supplied the entire plant for four major hydro-electric stations in India—Radhanagari, Nizamsagar, Sarda and Sengulam, and is manufacturing five—50 MW Water Turbine Generating Sets for the Rihand Power Station, U. P.

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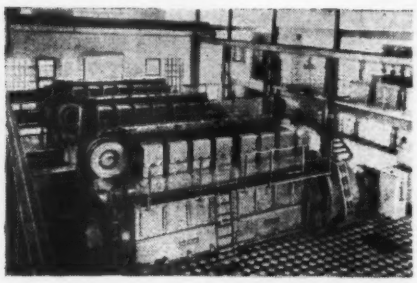

DIESEL. Three 'English Electric' Diesel Alternator Sets installed at Saateni Power Station, Zanzibar. The total output of the engines is 3,936 B.H.P. at 375 r.p.m. and the Station supplies the Island with a large part of its electricity.

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Role of Central Water and Power Commission in the Field of Power Transmission

By M. HAYATH
and V. VENUGOPALAN

The programme for the large-scale development of several Hydro and Thermal Power Schemes in India under the Second Five-Year Plan, which will no doubt be maintained and augmented under the Third and successive Five-Year Plans, implies an extensive growth of transmission systems. At the beginning of the year 1957, there were about 10,500 circuit miles of overhead transmission lines operating at 66 kV and above. This mileage is indeed a very small figure for a country with an area of over 1.26 million sq. miles and a population of 380 millions. An idea of the comparative status in this regard may be had from the fact that France had about 12,500 circuit miles at 150 kV *and above* in the same year, corresponding to an area of 212,900 sq. miles and a population of 43.6 millions. However, with the increasing tempo of activity in the field of power development, there is bound to be a substantial increase in the mileage in the future years. As the cost of transmission systems represents a major portion of the total capital outlay in any electrification project, it is clear that larger and larger sums of money will be spent on building transmission systems under successive Five-Year Plans. In order, therefore, to effect all possible economies and use the available resources to the maximum advantage, it is imperative that the technique of planning, designing and constructing transmission systems and standardisation of equipment develops on sound and rational lines. With this object in view, this Commission has been endeavouring to fulfil the various duties and responsibilities that have devolved on it during the past few years. This article attempts to give a resume of the activities of the Commission in the field of power transmission.

Codes of Practice and Standardisation

As a step towards the rationalisation and simplification of the practices followed in the country in regard to the design and construction of transmission lines, this Commission has issued the following publications:

(i) Code of Practice as regards the wind pressures and temperature variations for the design of overhead power lines. This Code is finding wide application throughout the country.

(ii) Code of Practice as regards the factors of safety for overhead line conductors. The recommendations contained in this Code have since been incorporated in toto in the Indian Electricity Rules, 1956,

The Commission was actively associated with the Railway Board in studying the regulations governing the crossing of overhead power lines over railway tracks, as issued by the various Regional Railways prior to their integration, and the practices followed in other countries like the U. S. A., U. K. and Canada, with a view to simplifying and evolving a uniform code of practice applicable on all the Indian Railways. The revised 'Regulations governing the placing of electric transmission lines across Railway tracks', issued by the Railway Board in 1955, is on an outcome of these efforts. These Regulations ensure good deal of simplification and economy in respect of railway crossings and uniformity throughout, the country, and have been widely welcomed and followed by the concerned authorities in the country.

The above Regulations are applicable to non-electrified railway tracks only. Now that the programme of electrification of certain sections of the Railways under the current Five-Year Plan is in the course of implementation, and more and more sections would come up for electrification in subsequent years, it is extremely desirable that a Code of Practice is evolved to regulate the placing of power lines across electrified railway tracks. With this end in view, the Commission has already taken up a detailed study of the practices obtaining in other advanced countries. The matter will be finalised in collaboration with the Railway Board so that a Code of Practice applicable to electrified tracks may be issued on an agreed basis.

This Commission has recently taken up the study of the practices and regulations governing the routing of overhead power lines near aerodromes. With the rapid industrialization taking place throughout the country, the various power systems are expanding, thus necessitating extensive transmission networks, especially in the vicinity of big cities, practically all of which fall in the category of International Airports or their alternates. The necessity for arriving at satisfactory arrangements to the mutual satisfaction of the power supply authorities and the Civil Aviation Department in regard to the routing of overhead power lines in the vicinity of aerodromes, has already arisen and is bound to be felt more and more in the future years. With a view to assisting the Electricity Supply Undertakings in determining the routes of their overhead lines, it is proposed to evolve a Code of Practice on the subject in collaboration with the Civil Aviation Department in the light of the practices in vogue in other advanced countries and also the international regulations in this regard.

The extensive growth of transmission systems in the country has brought to the fore the question of economy in the use of steel for transmission line towers. Under the Steel Economy Programme, the Indian Standards Institution have taken up the

preparation of a Code of Practice for Transmission Line Towers, and this Commission is rendering the necessary assistance in this regard. The Code of Practice aims at the rationalisation and simplification of the practices followed by the various authorities in regard to the design of towers, and it is expected that significant economies would be achieved thereby in the use of steel.

Studies on the economics of the various types of supports for lines below 66 kV have been made and a publication entitled 'A New Type of Overhead Line Supports' has been issued laying emphasis on the economic aspects of standard R.S. joists and channel in three stepped sections with bolted or welded joints.

As regards wood poles, necessary assistance was rendered to the Indian Standards Institution in the preparation of an Indian Standard Specification for Wood Poles for Overhead Power and Telecommunication Lines which was issued in 1957. While efforts are being made to ensure that the available resources of wood poles in the various regions are used within economical distances by the Electric Supply authorities in the country, there is at present a general lack of availability of suitable wood poles in sufficient lengths and quantities. Substitutes like RCC and prestressed concrete poles, have, therefore, to be considered wherever possible. Accordingly, this Commission was called upon to assist the Indian Standards Institution in preparing a Specification for Reinforced Concrete Poles for Overhead Power and Tele-communication Lines. This Standard was finalized and issued by the I. S. I. in 1957. A similar Standard for Lamp Standards has also been prepared and finalized and is expected to be issued shortly. However, the conventional concrete poles have serious limitations inasmuch as they are heavy as compared to rail poles, steel tubular poles, and wood poles, and their transportation to the site usually presents a problem. In recent years, prestressed concrete poles have gained considerable importance and they are being used in large numbers in other countries and also in India, as these are lighter and use much less quantity of steel than the usual RCC poles. Necessary assistance is being given to the I.S.I. in preparing an Indian Standard Specification for Prestressed Concrete Poles and Lamp Standards.

Apart from the above items of work pertaining to codification and standardisation, considerable assistance is being rendered to the Indian Standards Institution in the field of Transmission and Distribution. The officers of the Commission have been actively associated with the various committees and sub-committees set up by the I. S. I. for formulating Indian Standards and Codes of Practice on electrical cables, conductors, insulators, tower steel and other line materials and equipment, such as the Electrotechnical Division Council, Electrical Conductors and Insulators Sectional Committees and Sub-Committees, Sectional Committees for Structural Steel, Aluminium and its alloys, and Copper and its alloys, etc. Further, Draft Standards prepared by the Commonwealth countries and International Draft Standards issued by the International Electrotechnical Commission in regard to transmission and distribution line materials and associated equipment are carefully examined in this Commission and our comments prepared for formulating the Indian viewpoint for consideration by the Commonwealth countries and the I. E. C. The importance of such studies and close liaison with these Commonwealth and international organizations need hardly be emphasized.

Thunderstorm Data and Lightning Protection

Reliable data on thunderstorm activity collected over a period of years and proper analysis of fault statistics are essential for assessing the performance of overhead transmission lines against lightning disturbances and designing them for a pre-determined performance. At the request of this Commission, an Isoceraunic Map of India showing the level of thunderstorm activity in various parts of the country which serves as the basis for designing lightning-resistant transmission lines, was prepared for the first time by the Indian Meteorological Department in 1949. This Map is being revised every five years by the IMD in close collaboration with this Commission in order to bring the data more upto-date and make it more comprehensive.

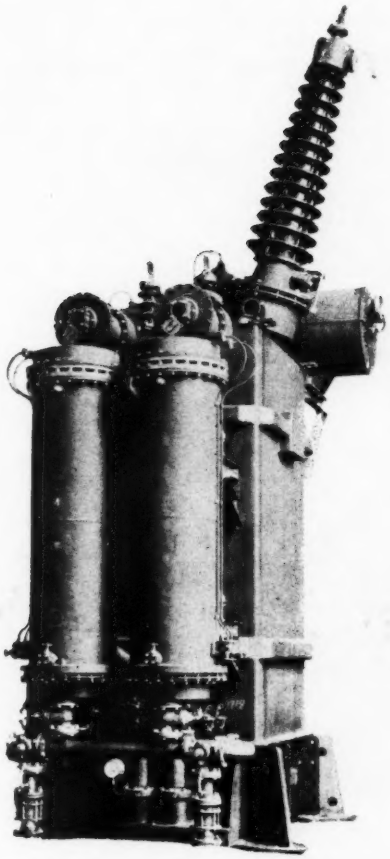
As the Meteorological stations are far flung and few in number, it was felt that the thunderstorm data collected by the IMD were not comprehensive enough. In order, therefore, to supplement the data being collected by them, arrangements have been made with the various major Power Supply authorities in the country for collecting similar data through their operating staff stationed in the power stations and sub-stations round the clock. The particulars collected are summarised in the Commission from year to year and forwarded to the IMD with a view to incorporating them in their data so that the future Isoceraunic maps may be based accordingly.

Side by side, the various principles involved in the design of transmissionl ines for giving a pre-determined level of performance against lightning strokes and the practices followed in other advanced countries were studied, and a publication entitled 'A Note on the Design of Lightning-Resistant Transmission Lines' was brought out in 1950. A copy of the Isoceraunic Map referred to above was also included as an enclosure to this publication.

Further detailed studies have been made during the past 2-3 years of the available literature on the subject of lightning protection of transmission lines, and based on these studies, the above mentioned publication is being enlarged and amplified. The revised booklet is expected to be issued in the course of this year.

Scrutiny of Project Reports

The Project Reports submitted by the State Electricity authorities for implementation under the Five-Year Plans are examined in this Commission on behalf of the Ministry of I & P and the Planning Commission. In so far as the transmission system is concerned, these reports are examined with a view to ensuring that not only are the various lines proposed in the reports adequate for meeting the immediate load



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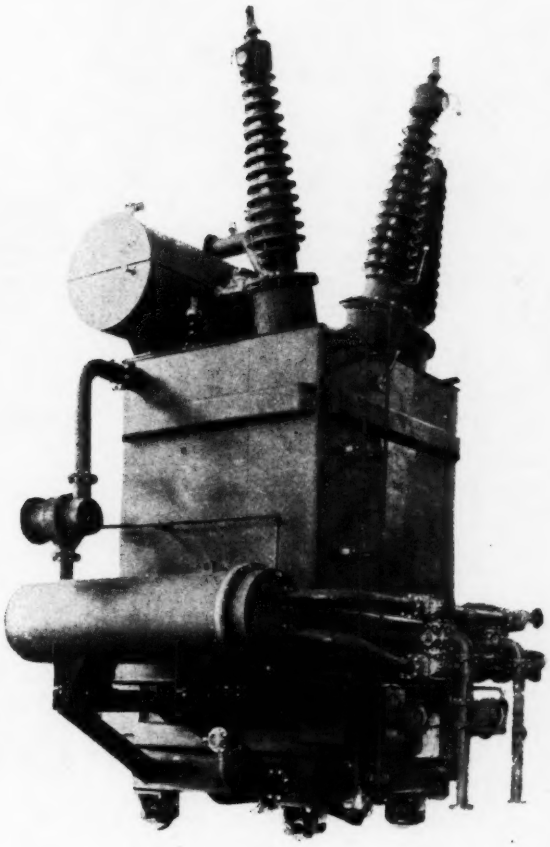

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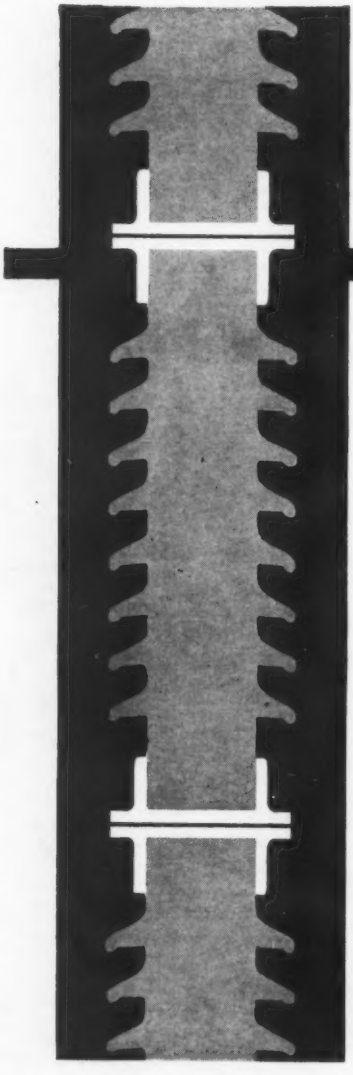

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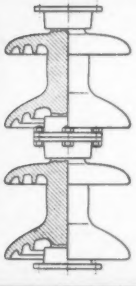

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demands in the region as well as those anticipated in the near future, but also lend themselves to possible future interconnections with the neighbouring systems. During the past 4-5 years, the transmission systems in respect of over 90 schemes covering a capital outlay of about Rs. 250 crores were examined in this Commission. An idea of the importance and usefulness of the scrutiny in the Commission may be had from the fact that in respect of 20 typical schemes costing over Rs. 56 crores, the Commission was able to suggest changes and modifications securing substantial saving in capital outlay without sacrificing in any way the technical requirements of the systems.

The Commission has also carried out from time to time investigations in respect of some projects on behalf of the States concerned and prepared Project Reports thereafter. Mention may be made in this connection of the Ukai Hydro-electric Project in Bombay State, the Kolar Hydro-electric Project in M.P. State and the Trisuli Hydro-electric Project in Nepal.

Preparation and Scrutiny of Specifications

At the request of the various Project authorities, this Commission has undertaken from time to time the preparation or scrutiny of the specifications for line materials and equipment in respect of their transmission systems. In this connection, mention may be made of the assistance rendered to the Damodar Valley Corporation, Koyna Hydro-electric Project, Chambal Hydro-electric Project (both Rajasthan and Madhya Pradesh), Pathankot-Jammu transmission line in Jammu and Kashmir State the Brahmaputra River crossing in Assam State, etc. In some cases reconnaissance survey of the transmission line routes was also undertaken with a view to fixing the design data and approximate schedule of quantities of materials before taking up the preparation of the Specifications.

Analysis of Tenders

The Commission has been assisting the project authorities like the Chambal Hydro-electric Project (both Rajasthan and M. P. State), Bhakra-Nangal Project, Koyna Hydro-electric Project, Umtru Hydro-electric Project, etc., in examining the tenders received by them for transmission line materials and equipment, and framing purchase recommendations. An idea of the extent of work in this regard may be had from the fact that during the past two and a half, years the approximate cost of the materials and equipment covered by the scrutiny was over Rs. 10 crores.

Preparation and Scrutiny of Tower Designs

Overhead transmission lines at voltages of 66 kV and above are generally carried on self-supporting towers. These towers generally constitute 30 to 35% of the total cost of the transmission lines. It is estimated that about one lakh tons of steel are required annually for tower fabrication in the country, and this will increase progressively with the expansion of power projects all over the country, and, therefore, the care that is required in evolving economical and safe designs need hardly be emphasized. This Commission is called upon from time to time to render the necessary technical assistance to State Governments and sister Government Departments like the All India Radio and the Civil Aviation Directorate either in the preparation of tower designs or in scrutinising designs submitted by the various Designers, and this work has formed one of the important phases of the Commission in recent years. During the past 2-3 years, as many as 65 transmission line tower designs for voltages ranging from 66 kV to 220 kV and about 25 designs for radio masts ranging in height from 70 ft. to 600 ft. have been scrutinised. The transmission line towers covered by the scrutiny relate to the various Projects, such as the Chambal Hydro-Electric Project in Madhya Prodesh and Rajasthan, Bhakra-Nangal Project, Rihand Dam Project, etc. Mention may also be made of the preparation of designs in hand for the towers required for the 33 kV line crossing of the Brahmaputra River near Pandu under the Umtru Hydro-electric Project in the Assam State. The river crossing span is nearly a mile in length and is perhaps among the longest tower line crossings the country.

Network Analyzer Studies

The scrutiny of the Network Analyzer studies of the various interconnected power systems, and participation in such studies whenever called up to do so by the concerned authorities, is a comparatively new phase of activity in this Commission. With the State grids getting more and more extended, practically all the major electricity authorities are studying their problems on the Network Analyzer at the Indian Institute of Science, Bangalore. The Analyzer Reports are forwarded to this Commission at some stage or the other for comments and these are examined in detail. As examples of such studies made in this Commission in recent years may be mentioned those relating to the Sharavathi Valley Hydro-electric Project in the Mysore State, the Rihand Transmission System and the Ganga Canal Grid Extensions in Uttar Pradesh, the Hirakud Transmission System in Orissa, the Machkund Transmission System in Andhra Pradesh, and the Madras System in relation to the Neyveli Project, the Kerala, and the DVC Transmission Systems. It may be stated that in most of these cases, considerable economies have been effected by the authorities. In some cases, the Commission directly participated in carrying out the studies on the Network Analyzer at the request of the concerned authorities. With the rapid development of the regional grids, there is no doubt that more and more work of this nature will devolve on this Commission.

Planning of All-India Super-Grid System

In order to derive the maximum benefit from the various power projects envisaged in the successive Five-Year Plans, a proper power development transcending State boundaries is essential. As each State is primarily interested in the power development in its own area, the development of power resources on the basis of inter-State co-operation and co-ordination is one of the important duties of this Commission. Interconnection of various State grids into regional grids by establishing regional Super-Grid Systems and gradual evolution of an All-India Super-Grid System are essential for deriving the maximum benefit from the various power projects. As a step towards this objective, this Commission has

undertaken the necessary preliminary studies for the establishment of a Super-Grid System for the Southern region. After a careful study of the various technical and economic aspects, proposals for a Super-Grid for the Southen zone will be framed by this Commission for consideration of the concerned authorities and for progressive implementation. Similar work will be taken up for other important regions in the country in course of time.

Hot-Line Crew Training Programme

'Hot-Line' maintenance is one of the latest techniques in the field of maintenance and repairs of overhead power lines by means of which the trained staff will be able to carry out most of the repairs and maintenance works on energised or 'hot' lines. Under an Operation Agreement signed in April 1955 between the Governments of U. S. A. and India, two Hot-Line Crew Training Centres have been established in the country, one at Bangalore and the other at Ganguwal (Punjab), to train Indian personnel in the techniques of 'hot-line' maintenance and repairs of overhead power lines. The necessary vehicles, tools and equipment and the services of two Training Instructors, one for each Centre, have been provided by the U. S. Government under the TCM Aid Programme. The training programme is initially for a period of two years at each of the two Centres. The trainees are selected from among the line staff and supervisory personnel who are working in and are sponsored by the various State Electricity Boards and major private Electricity Supply Undertakings in the country. The training programme for each batch of trainees lasts for about six months, and thus it will be possible to train four batches at each of the training centres. So far, three batches—two at Bangalore and one at Ganguwal—have completed their training. The trainees for these batches were drawn from the States of Madras, Mysore, Andhra Pradesh, Orissa, Punjab and Uttar Pradesh, and the Tata Hydro-electric Power Co.

In order to enable the various participating authorities to derive the full benefit of the Hot-Line Crew Training Programme by employing 'hot-line' techniques on their power systems, arrangements have also been made to supply each organization availing of the training facilities at both the Centres with a set of 'hot-line' tools and equipment. In this connection, the T. C. M. authorities have agreed to provide an additional aid towards the cost of twelve sets of tools and equipment to be allocated to the various authorities participating in the training programme.

It is proposed to bring out a Hot-Stick Manual in consultation with the American Instructors, detailing the procedure to be followed for the various 'hot-line' operations such as replacement of insulators and crossarms on the various types of structures, splicing conductors, etc., with particular reference to the line construction practices followed in different parts of the country. This would prove to be a valuable and permanent guide to the 'hot-line' crews in their day-to-day work.

Miscellaneous

While the conventional wired telephony and the power line carrier have their respective useful spheres of application, a comparatively new facility for power system operation and maintenance, the Radio Telephone Service, is being increasingly used in many advanced countries, and in recent years, in India also. The Commission has made a detailed study of this subject and issued a publication in 1957 entitled, "Radio Telephone Service for Power Systems". The radio telephone service is mainly intended for establishing communication between maintenance or breakdown gangs at intermediate points on the line and the adjacent sub-stations by means of mobile sets installed in lorries—apart from providing communication betwen power stations and sub-stations either as a supplement or an alternative to the carrier service depending upon the various technical and economic aspects involved.

The Commission has made a detailed study of the various methods adopted for making sag-tension calculations of overhead line conductors and brought out a publication in 1956 entitled "Sag-tension Calculations of Overhead Line Conductors". The publication includes also the 'nomographic' method developed in Sweden for doing the calculations quickly and with a fair degree of accuracy.

Conclusion

It is obviously not possible in an article of this nature to detail all the activities of the Commison in the field of Power Transmission. However, it is hoped that this resume gives an idea of the technical assistance being rendered by this Commission to the various Project authorities and other organizations in the country and also the efforts being made towards simplification and standardization and thereby achieving economies in the design, construction and maintenance of Transmission Systems.

Continued from page 11]

Role of Central Water and Power Commission in the Progress of Rural Electrification

for catering to all the industrial loads, the tubewells etc. programmed during the Plan. The total quantum of high tension feeder lines would thus be very appreciable at the end of the Second Five-Year Plan, embracing a very wide area. It is anticipated that it would be possible to supply electricity with the least possible expenditure to a large number of villages round-about such a spreaded network of lines. The possible coverage in the Third Five-Year Plan, therefore, may easily be much more than was possible during the Second Plan.

It is in the context of such rapidly expanding volume of work that the various efforts taken by the Central Water and Power Commission are significant.

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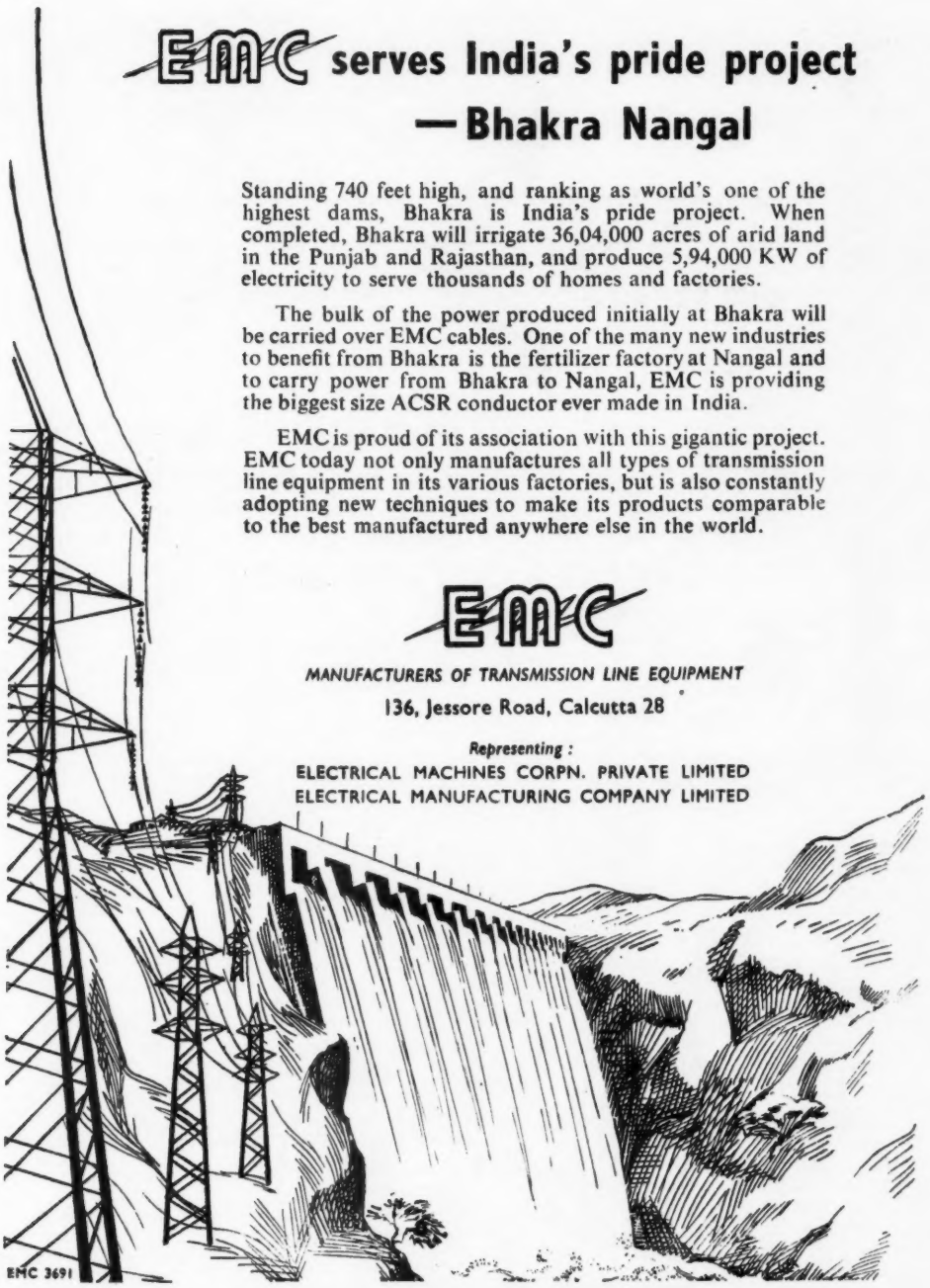

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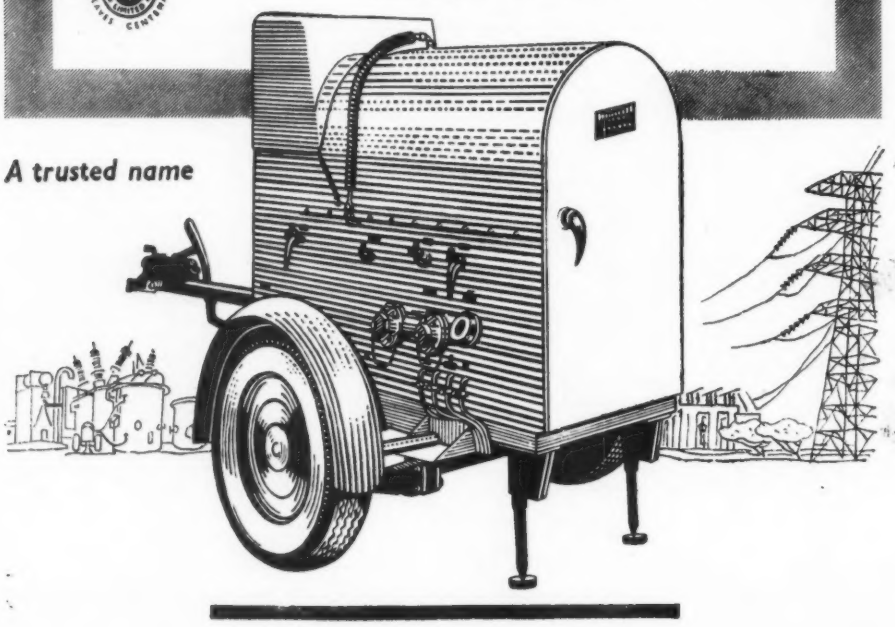


Development of A Port on the Mahanadi Mouth at Paradip

By YADAVA MOHAN

The Orissa coast has many an estuary, and can also boast of a sea face which extends to nearly 300 miles on the East Coast; but it needs to be stressed that Orissa is yet to have a harbour capable of handling ships of some size.

There were, of course, nine minor ports on Orissa, namely, Subarnarekha, Chanua, Balasore, Laichhunpur and Churaman (all in Balasore Bay) Chandbali (Dhamra), False Point Harbour, Puri and Gopalpur. But the silting of the river mouth has accounted for elimination of many of these, while the position of the others has also deteriorated. Puri and Gopalpur have not handled any cargo since long, while Chandbali on the Baitarani river is just managing with the trade of the old port of Dhamra.

The famine of 1866 in Orissa, set the Government looking for some suitable sea entrance for the rushing in of supplies, and False Point Harbour—six miles off the Mahanadi mouth—came in handy for the purpose. Naturally, serious consideration was given whether False Point might not be developed into a major port of Orissa. But, rather unfortunately, this erstwhile harbour shoaled up soon after, and False Point was off the list of possibilities by 1924.

But the interest in rigging up a port for Orissa was revived and kept alive, firstly by thePort Technical Committee, appointed by the Government of India in 1946, as also by the inauguration of the Hirakud Project. The Port Technical Committee approved investigations for a deep sea port between Vishakapatnam and Calcutta, while the Hirakud Project opened out the rich possibilities of a port situated at the Mahanadi mouth and connected with the Mahanadi system for purposes of exporting the industrial and agricultural products of Orissa overseas as also to other Indian ports.

At the request of the Orissa Governmrnt, the Central Water and Power Commission took up investigations and hydrographical surveys on the Orissa coast with a view to the selection of a site for a suitable sea port.

The estuaries at the Dhamra, the Mahanadi and the Devi mouths seemed to offer possibilities for the development of such a port, and surveys and investigations were carried out on all these sites during the years 1948-50 with a view to select the best among them.

These surveys revealed that the Devi mouth is hardly suited for establishing a mojor or a minor port, owing to the unsteadiness of its estuary, and shallow depths in the river. This river runs rather wild during the monsoon, causing numerous channels, islands and shoals just above the mouth. The choice was therefore limited between the Dhamra and the Mahanadi mouths.

In view of the fact that the Chandbali port was handling the coasters through the Dhamra estuary, it was first felt that the Dhamra mouth near its junction with the Matai Nala (16 miles below Chandbali) might be the site for such a port. Detailed investigations of the Dhamra were therefore undertaken.

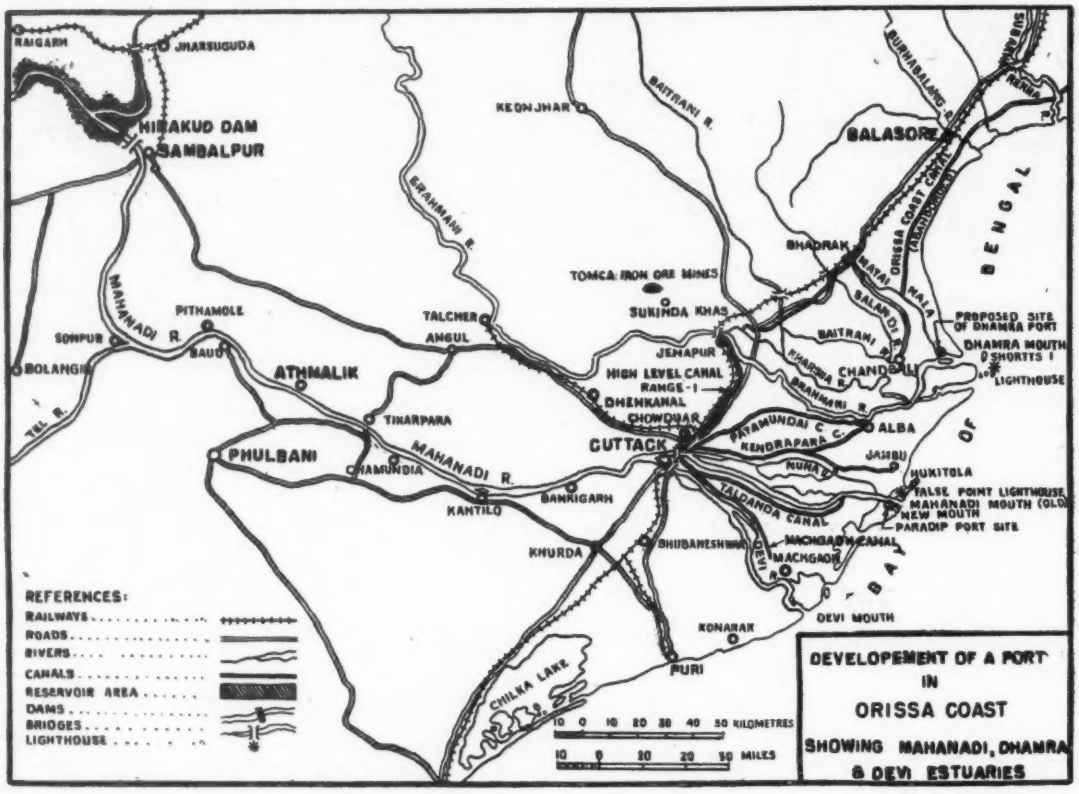
But, when similar surveys of the Mahanadi were completed, it was found that the Mahanadi was the better site, owing to better nautical condition of the estuary, better facilities for inland communication, central location as well as availability of fresh water.

The possible harbour site on the Dhamra is near its junction with the Matai Nala, about 15 miles by land from Chandbali and 33 miles from Bhadrak which is the nearest railway station. But the drawback is that none of these is connected by road with Dhamra. Cuttack is about 109 miles via Bhadrak by land and about 90 miles by waterway from Dhamra.

Also the nautical conditions of the Dhamra are not favourable at the estuary, though quite sizable depths are available near the suggested harbour site. There are three sand islands at the mouth of the river, making three approaches from sea to the river. But these channels are always changing in depth.

The southern channel which had a minimun of 18 ft depth in 1940 was found almost shoaled up in 1949. The middle channel was also not suitable while the northern channel was being used by ships for Chandbali port. There are some permanent shoals in the sea in front of the middle channel, known as the Palmyra Shoals. Besides, there are some sand bars in the stretch of the river from the mouth to the port site. The real problem here is the choice of the approach channel for improvement. Much dredging and other conservancy works would therefore be necessary for improvement as also for the maintenance of any of these channels.

The quick and unpredictable changes in the channel course and the gradual extension of islands between these channels (as between the charts of 1949 and 1940), however, stress the instability of the delta area. It is therefore to be feared that dredging alone will not help to maintain the channel. A training wall also may have to be constructed, cost of which would be rather prohibitive, besides maintenance cost, which



will also be heavy due to the heavy swell in the sea. Add to this electricity and fresh water supplies are also not to be had in the vicinity of the suggested port site.

The Mahanadi estuary however is more centrally located. It is about 220 miles south of Calcutta, and 280 miles north of Vishakapatnam port, and only 60 miles from Cuttack, the trade centre of Orissa and 75 miles from Bhubaneswar, the capital of Orissa. Inland communication facilities are also more abundant at the Mahanadi than at the Dhamra site. A new railway line, about 60 miles long, may have to be constructed to connect this port site with Cuttack, the nearest Railway Station. A motorable road from Cuttack to Anantapur near Paradip Lock of Taldanda canal is already in existence and extension of this road by about 10 miles would connect it with the port site on the Mahanadi mouth. Waterway connection between Cuttack and Paradip also exists by two different routes, the one via Kendrapara canal, and the other via Taldanda canal. Approximate distances from the Paradip port to Cuttack by these waterways are about 63 and 60 miles respectively. Ample fresh water can also be provided from the Taldanda canal about eight miles away. Since various towns situated on the Taldanda canal (nine miles from the port site) are being electrified, electric supply will also be available at cheap rate at the suggested port site.

In addition, the marine conditions of the Mahanadi are much superior to those at the Dhamra. A survey carried out in 1949 reveals that the Mahandai has a very deep channel, alongside the right bank near Lion's Rump, the depths varying from 25 ft to 50 ft at datum and width from 500 ft to 600 ft between 24 ft contours and about 750 ft to 1,200 ft between 18 ft contours. The rise of the tide at springs in the estuary varies from 6 ft to 7.5 ft and that at neaps from 3.5 ft to 5 ft. This site is only 8 miles below the Paradip Lock and seven miles above the mouth and is therefore very favourable for developing a sea port for ships drawing about 30 ft. Below this reach, the channel is also deep throughout, with depths varying from 22 ft to 30 ft below datum. Depths of 28 ft to 37 ft at high springs may therefore be expected to obtain at this spot.

Just below the Lion's Rump, the river was then running parallel to the sea, separated from the coast line by a narrow sand strip. The width of the sand strip varied from 150 ft near its base to 3,900 ft near the mouth. To shorten the approach channel below the Lion's Rump or the port, a new mouth can be opened by giving a straight cut two miles lower down. This step is also expected to facilitate the easy maintenance of the mouth since there are no adverse factors in the Mahanadi mouth (as at the Dhamra), except for the littoral drift which is an usual feature on the East Coast of India.

The survey therefore showed clearly that the Mahanadi mouth was a better site than the Dhamra for establishing a port. The investigations on the Dhamra were therefore closed down in 1950, while detailed investigations were started on the Mahanadi mouth.

The problem of selecting a suitable site was also referred to a group of French engineers (which was known later as the French Mission) who visited India in 1951. They also concurred that the Dhamra was not suitable for development of a deep sea port owing to its unfavourable geographical position, undesirable effect of various natural forces at the mouth, such as coastal drift, tidal currents, heavy silting and presence of shoals at the mouth and in the sea more particularly the Palmyra Shoals in the Bay of Bengal abreast of the Dhamra mouth. It was also pointed out that in view of reasons already listed above Paradip was the better site.

In the opinion of the Mission, a medium size port at the Dhamra mouth could handle only ships up to 20 ft draft and 5,000 tons dead weight—at a cost of about Rs. 11 crores (Rs 6.5 crores for construction of of harbour break-water, etc. and Rs. 4.5 crores for improvement of internal communication by rail, road and waterways, as also works for supply of fresh water).

The advantages of a port on the Mahanadi mouth at Paradip are obvious: the port would serve to save expensive inland transport by rail and by canal of all the produce of the Mahanadi basin. The only adverse factor to contend against and circumvent will be coastol sand drift, which probably exceeds 1,500,000 tons a year, and which travels from south to north, whereas the Dhamra is also affected by seasonal and tidal currents.

The French Mission felt that the best solution for coastal sand drift would be to cut a channel through the sand spit at its base, and protect it by breakwaters on either side. In this connection they also suggested two different designs of breakwaters projecting into the sea for stabilising the channel.

They however observed that the final decision about the alignment of breakwaters should be embarked upon only after proper model studies. The cost of Paradip post was estimated at Rs 9.35 crores as against Rs. 11 crores for the Dhamra site. This includes the cost of breakwaters, dredging, two berths and other necessary works relating to harbour, and also for provision of railway and road facilities and improvement of Taldanda Canal.

As anticipated by the Mission, a breach at the sand spit occurred at its base near Lion's Rump in 1951, and a new mouth opened up directly in the Bay of Bengal. Gradually the old mouth is being silted up and the new mouth is stabilising. As desired by the Mission, the Central Water and Power Commission conducted further studies and field investigation of the Mahanadi since 1952 and collected data for model experiments on the port site. Hydrographical survey of the coast at approaches from False Point to a mile south west of Lion's Rump was also carried out by the Indian Navy in 1952 to ascertain the depths at approaches of the Mahanadi estuary. This survey indicated that the deep water contour in the sea is about half a mile from the shore.

Model experiments have also been in progress at the Central Water and Power Research Station since 1955-56, their object being to determine the best alignment for the breakwaters, location of port, effect of heavy swell on ships berthed in the harbour, effect of rectification of the river, prevention of accumulation of sand drift at the mouth, etc. These experiments are expected to be completed in the near future.

The establishment of a port on the Mahanadi at Paradip will thus fulfil a long-felt need for a port in Orissa, and will also help to ease up the congestion of the Calcutta port, and might also prove useful in an emergency.

The proposal to export iron ores from the Sukinda (Tomca mines) located on the left bank of the Brahmani (about 50 miles north-east of Cuttack, where very high grade iron ore deposits have been discovered) to overseas countries through the proposed Paradip port has been under active consideration by the Government of Orissa, and a few vessels have already been loaded during 1958. Extensive high grade iron ore deposits have also been reported in the districts of Koraput, Bonai and Mayurbhanj. When fully developed, the State Government proposes to export nearly 2 million tons of ore per annum the target by 1961 being half a million tons. Paradip port has already been declared as minor port by the State Government.

In this context the problem of the Paradip port was also examined by a group of Japanese technical experts who visited Paradip in July 1956 for spot survey for the export of iron ores from the Sukinda mines. The Japanese Mission also endorsed the view already expressed that the Mahanadi estuary is the best site for a port on the Orissa coast. They are also conducting experiments on models of the Mahanadi estuary at the Institute of Industrial Science, University of Tokyo, to study drifting conditions of sand that affect the mouth and harbour basin. Studies are also expected to be made for designing the alignment of the break-waters in respect of their length, shape and width of entrance between them. The merits and demerits of the coastal harbour and estuary harbour are also being examined to decide if a harbour on the coast is feasible.

The Japanese Mission have advised development of Paradip in three stages:

In the first stage Paradip will be a minor port. The ships will be anchored at sea, and cargoes will be brought to and from ships by lighters. These off-shore loading and unloading will be possible only for a few months during winter. In this stage, dredging work, construction of the training wall and reclamation, etc. will be carried out.

In the second stage, a quay wall, sea wall, stores, breakwaters and other facilities such as buildings, electricity, stocking yard for ores, etc., dredging and reclamation of banks, necessary works for loading and unloading in the harbour, are envisaged. This stage is to be taken on hand only when the mines of iron ores develop and necessary inland transport connection to the harbour and handling facilities exist. The first and the second stages are estimated to cost about Rs. 8.67 crores.

The final construction of the port is however to be in Stage III. During this stage is envisaged the construction of a wet dock with a lock gate for ships, having a number of quay walls as in the ports at Calcutta and Bombay.

In the opinion of the Japanese Mission, the Paradip port is to be considered for the present only as a port for exporting ores. However, with the growth of internal communications through rail, road and waterways, is also with the development of the Mahanadi valley industrially, the port can easily be expected, in the near future, to develop into an all trading commercial port.

The Government of Orissa have already taken necessary steps to start the preliminary works of the first stage in connection with the export of iron ore from Sukinda. The ores are now being stocked at Paradip for export to overseas.

The iron ore is being brought from the mines to the Jenapur Lock at the tail end of the High Level Canal Range 1, a distance of about 22 miles by trucks; and from there it is transported to Paradip by country boats of capacity 20 to 60 tons through the High Level and Taldanda Canals, a distance of about 100 miles. About 100 boats have been commissioned for this purpose. Two dumping yards, 200 ft by 100 ft. with temporary wooden jetties, have also been constructed at Paradip. Suitable self propelled and dumb barges have also been procured for loading the iron ore at anchorage. The loading of iron ores started in Novemeber 1958, and about 50,000 tons of ores are expected to have been exported by April 1959 to foreign countries.

This is indeed progress, and it is only to be expected that when once the port starts functioning, its development will be at a rapid pace. Many industries can be expected to take root and grow wtih the progress of the successive Five Year Plans, and it is only reasonable to hope that Paradip will grow before long into an all-weather major port on the east coast of India, which will be able to handle shipping and coal traffic of very respectable size.

Continued from page 16]

Working of the Silt and Construction Material Directorate

(*a*) Engineering properties in soils.
(*b*) Development of economic alternatives to stone for flood protection.
(*c*) Standardisation of the use of Surkhi and other pozzolanic materials in mortar and concrete.
(*d*) Principles of mortar and concrete mix design.

The work on the first two problems is being conducted in the Soil Mechanics Section, and on the remaining two in the Concrete and Materials Section of the Directorate.

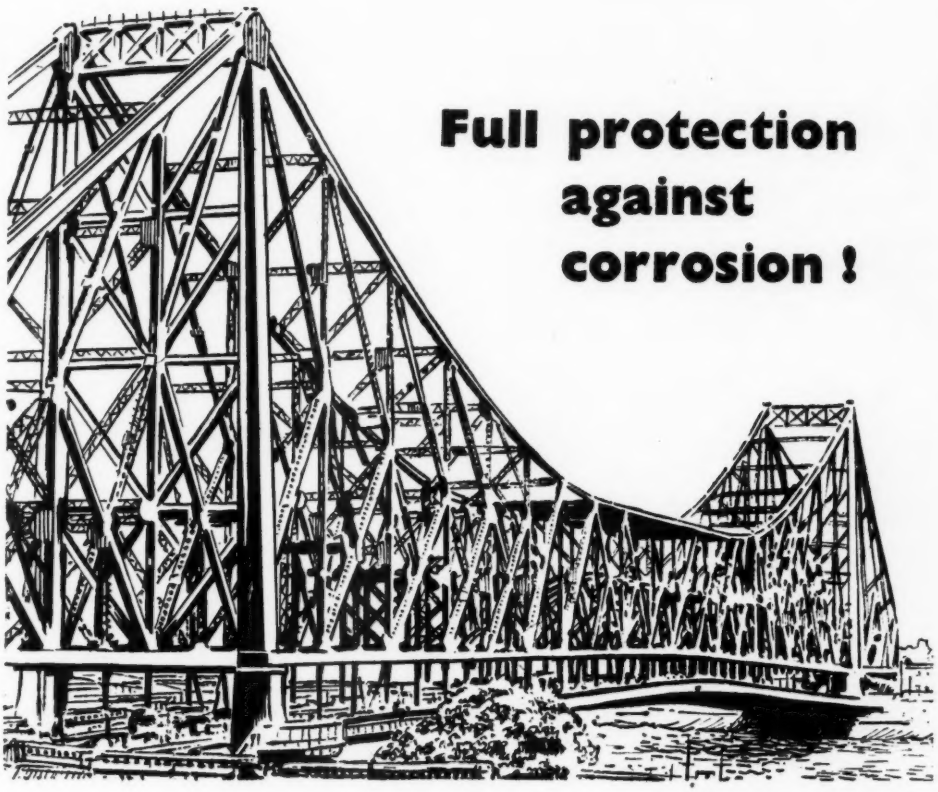
During the period that the Silt and Construction Material Directorate has been functioning, it has been the practice to prepare a report each year giving details of all the experimental work done by the various Sections during that period. Moreover, besides the reports sent to Department on testing work, surveys etc., a number of papers had been submitted for discussion at seminars, meetings, conferences etc., or for publication in technical journals. The Directorate has been called upon by the States such as Andhra Pradesh, Bombay, Bihar etc., and several Projects to render advice with regard to specific technical problems, revised project schemes etc.

It will be seen from the above that the Silt and Construction Material Directorate is developing on lines which should enable it to fulfil the main objectives for which it was instituted by the Commission in December, 1954. A planned co-ordination between the Designs and Planning Organisations of the Commission and the Silt and Construction Material Directorate should prove very useful.

Polyethylene Production Expands

The Polyethylene unit of the Plastics Company at Whiting, Ind., Plant has recently been started. The new unit has a capacity of 80 million pounds of high-pressure polyethylene a year. It was anticipated at the time the new unit was authorized in the summer of 1957 that it would have a capacity of 72 million pounds. Improvements in production techniques, which were incorporated during the construction stages, have increased the capacity. This brings Union Carbide's total capacity for producing low-density polyethylene to over 400 million pounds a year.

Carbide Chemical Company of Canada Completes second major Polyethylene Expansion at Montreal East, Quebec, plant. The planned expansion in polyethylene production capacity to 40 million pounds annually, which was announced in April, 1958, has been completed and the plant is in full operation. Engineering on the third expansion program, designed to increase production capacity to over 65 million pounds annually, is well under way with the new facilities scheduled for completion in mid-1960. At that time, the Montreal East plant will be the world's third largest polyethylene plant outside the United States.



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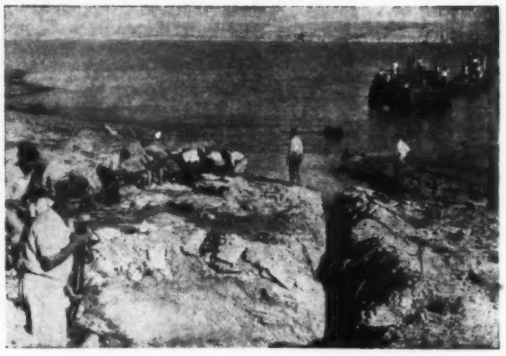

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Role of Central Water and Power Commission the Progress of Rural Electrification

By S. S. KUMAR
and A. P. SEETHAPATHY

Due to the enormous benefits, both direct and indirect, and the importance of serving the majority of the community, the extension of electricity to the rural areas has been given its due attention in the recent past by the various States and also by the Centre. The progress upto the beginning of the First Five-Year Plan in the whole country was rather meagre as only the towns were provided with electricity. Little or no attention was paid to the rural parts. It has to be admitted, however, that there had been some progress of rural electrification in the southern parts of the country though this was not as a result of any particular programme. Specific programmes were initiated by the Govt. of India only in the later part of the First Five-Year Plan and the various State Governments were enthused to take active steps for furthering rural electrification.

In the beginning of the First Five-Year Plan, we had hardly about 3,000 villages electrified in the country and another 4,000 were added during the First Five-Year Plan, taking the total to 7,000. The specific programmes initiated by the Govt. of India, such as the expansion of power facilities for increasing employment opportunities and the discussions and the resolutions passed at the various Engineering Seminars in regard to rural electrification and the special efforts made by some of the State Govts. in this direction began to yield results towards the end of the Five-Year Plan.

Large programme of irrigation by tubewells had also a significant effect on the extension of electricity to the rural areas. This was especially so in the northern States of Bihar, U. P. and the Punjab where the tubewell programme was concentrated.

In the Second Five-Year Plan, there is an ambitious programme of rural electrification covering about 10,000 villages. It is hoped that not only this target will be achieved, but probably, given suitable encouragement and under favourable conditions, it may even be exceeded. About 4,500 villages have already been covered during the first two years of the Plan.

The problems facing the rapid expansion of rural electrification in the country are numerous and these have been engaging the attention of the Central Water and Power Commission. The action taken by this organisation in regard to some of these is described below:—

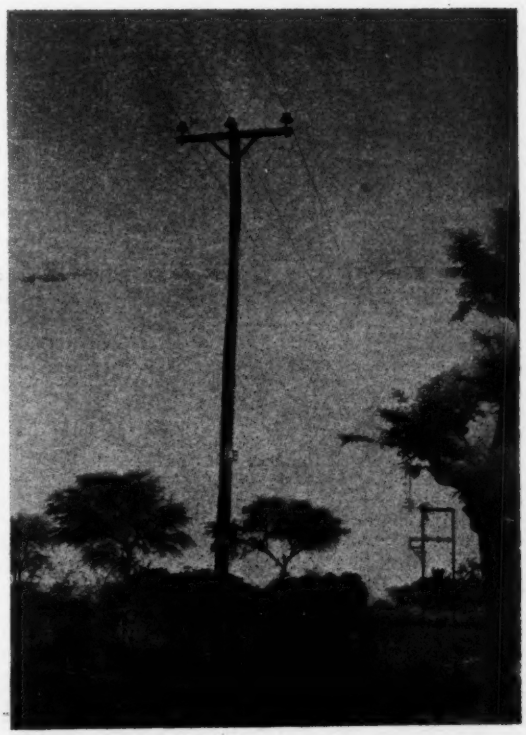
Rural Line Standards

The load charactertistics in the rural areas are poor and few schemes can be worked out which will be paying and self-sufficient in a period of 5 to 10 years. Utmost economy in the designs and liberal use of indigenous materials are, therefore, essential factors.

Standardised line designs for adoption over a wide area will bring down the cost of materials, ensure uniformity in line construction practices and also result in the limited use of experienced personnel on construction jobs. The last is a great advantage, especially when we are short of technical personnel in the whole country.

The Central Water and Power Commission has been engaged in the preparation of standards for rural electrification schemes for the entire country. The designs relating to 11 kV lines and Low-Tension lines, based on the Indian Electricity Rules 1956, for wood supports have been finalised for 10, 15, 20 and 30 lb. wind regions.

Feeder lines in rural area in Bombay



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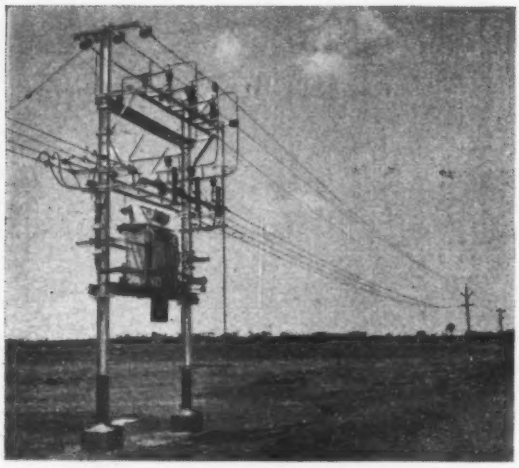

A rural distribution transformer in Madras

The above standards will be followed by a Handbook of Standard Units and Standard Specifications for various materials required for Rural Electrification works. This will not only facilitate estimating of stores, but would also minimise the work of the various departments which would be purchasing materials in bulk for rural schemes.

The adoption of common standards all over the country will enable the manufacturing concerns to engage in the manufacture of materials on a standard systematised basis. This would as a consequence not only bring about their optimum production capacity, but would also result in the reduction of prices and the delivery periods for various materials.

Revision of Standards for Rural Areas

The Central Water and Power Commission has been further aiming at the possible adoption of lower standards for rural lines commensurate with safety in operation and maintenance required of such lines. In the All-India Power Engineers Conference held in Bangalore in 1957, there was considerable discussion in regard to the relaxation of certain I. E. Rules (1956) for adoption, especially in the rural areas. A Committee was appointed to go into the question in detail. The Committee has finalised its recommendations in regard to these relaxations. The main recommendations which have a large bearing on the rural line designs are:

(1) factors of safety in the case of metal supports and wood supports to be reduced to 1.5 and 3 respectively from the existing 2 and 3.5;

(2) the lowering of the ground clearances in sparsely built up rural areas;

(3) the omission of guards between high and low voltage; and

(4) the restricted use of safety and protective devices like caution boards, anticlimbing devices.

All the State Govts. have been requested to give effect to these relaxations with a view to bring down the cost of rural electrification. A new set of Rural Line Standards based on the above revisions is under preparation.

Colombo Plan and T.C.M. Aid

Certain allotments of funds under the Canadian Aid (Colombo Plan) and also from the T. C. M. aid have been utilised for furthering our objectives of increased rural electrification. Under the Canadian Aid, 249 diesel generating sets of capacities ranging from 25 kW to 100 kW with the connected switch-gear and accessories have been received. These are being utilised mostly in large villages which are not likely to be connected to the grid lines in various States for some years to come. These installation will serve as pilot projects for the initial development of load with the ultimate objective of being connected to major grid transmission lines thus advancing the benefits of electricity to the rural population.

Under the T. C. M. programme, certain essential materials like supports, insulators, conductors and lightning arrestors, are being imported for use entirely on rural electrification schemes. The supply of about 88,000 of $5'' \times 3'' \times 30'$ long R. S. joists has been completed. Most of the other materials have also been received at site.

Wood Poles

Our efforts in the direction of using more and more indigenous materials are now concentrated on the procurement of wood poles from the indigenous forests. It is roughly estimated that we could utilise easily about one million poles during the Second Five-Year Plan period on rural electrification schemes alone. Against this quantity required, hardly a small fraction has been readily available from the State forests

A sugarcane crusher in a rural area in Andhra Pradesh

as these had not been planned for such exploitation purposes. Due to our efforts a Central Board for the procurement and supply of wood poles has been formed with the Insepector-General (Forests) as its Chairman and most of the Chief Forest Conservators as members. We have also taken pains to bring home to the Forest Departments in various States the need for a planned programme, especially with regard to afforestation so that quite a substantial part of the needs of rural electrification may be served at least in the years to come.

Tests on Wood Poles

Certain experiments are being conducted on wood poles in the Forest Research Institute, Dehra Dun. One set of experiments consists of testing full length wood poles of various species and lengths and classes to see how the actual strength obtained compares with the estimated strength in the Indian Standard Specification 876. If the physical tests indicate higher strength for different classes of poles than those estimated according to the species of timber, the idea is to reduce the factors of safety (presently 3.5 and suggested to be reduced to 3 in the case of rural areas) to even less, say 2.5 which would considerably reduce the cost of the supports or alternatively enable adoption of thinner poles falling under lower category for the same duty. The use of poles of lower classification obviously would result in more number of poles being made available for the rural schemes from the indigenous forests.

Splice-Jointed Poles

The second category of tests relates to the testing of splice-jointed poles. Jointed poles will result in smaller lengths being used and also solve the problem of transport faced on winding roads in the mountainous areas. It is also expected that by the utilisation of jointed poles the resources from the indigenous forests are likely to increase.

We have suggested in a recent Conference of the Central Board of Forestry at Shillong that while apportioning the produce of the various forests to the various consumer interests, the claims of rural electrification should also be given due importance.

We hope all the above measures would result in considerably more number of poles being supplied from the indigenous sources to rural electrification schemes.

Better exploitation of the forests in Andaman Islands, and availing the resources in the neighbouring countries are also under serious consideration.

Other main materials required for rural schemes, such as distribution transformers, conductors, etc. are mostly obtainable indigenously. H. T. insulators and lightning arrestors are mostly being imported from abroad at present, but it is likely that the import of 11 and 33 kV insulators will be considerably reduced when the Mysore Govt. Porcelain Factory goes into full production, thus making us more or less self-sufficient in rural line materials.

Statistics

We have also embarked upon th collection of accurate statistics in regard to electrified places in the rural areas. Classification of a village as an electrified unit had been varying from State to State. Villages having electricity for tube-wells or other isolated purposes had not been classified uniformly by all the States. The demarcation of villages was also not in accordance with the 1951 Census Report of India. All the data are now being reviewed and put on the same uniform basis for the whole country. Any village which has been supplied with electricity for any purpose whatever would be classified as an electrified village for purposes of statistics, and no hamlet or part of a village which has not been recorded as a separate entity in the 1951 Census Report will find a place in this list as a separate item.

Yardsticks for Sanction of Schemes

The yardstick for sanction of schemes to cover the rural parts has a large bearing on the likely outturn by the various State Electricity Boards/State Govts. though the State Govt. Departments may not experience as much difficulty as the State Electricity Boards. The yardsticks have been varying widely from State to State. The Kerala State Electricity Board has been adopting a rule of thumb of 5% gross return for sanction of rural electrification scheme for execution. In the case of Mysore, rural extensions are being sanctioned on the basis of 5% gross return in some areas and 7½% in others. Obviously, these percentages cannot cover the entire expenses on the capital investment including depreciation, interest and other charges. In the case of Madras, Andhra and the Punjab, the gross return expected varies from 10 to 12½% and these themselves are stated to be insufficient (as per recent details furnished) to meet all the charges at the present time. Most of the other States generally adopt the method of working of net return after a developmental period of 5 to 10 years. If this return covers the interest charges, the scheme is sanctioned for execution. This yardstick, of course, ensures that every rural extension is a paying proposition by itself, but as things stand at present, it will be very difficult to pick out and formulate a large number of schemes on this basis in the rural parts, especially where the coverage has already been on a wide scale and the better villages have more or less been served.

The environment for large scale rutal electrification is steadily growing. On the one hand, we have several thousands of miles of high tension distribution feeders being laid by the various States which facilitate extension of electricity to the rural areas adjoining these feeder lines. On the other hand, We have an increasing population which is electricity-minded and conscious of the advantages of the use of electricity for various needs.

In 1951, only about 11,000 miles of 11 and 22 kV feeder lines were available in the country. These usually catered to the rural loads. This mileage has increased to about 22,000 by the end of the First Five-Year Plan. During the Second Five-Year plan, we may expect an addition of a similar mileage

[*Continued on page* 4

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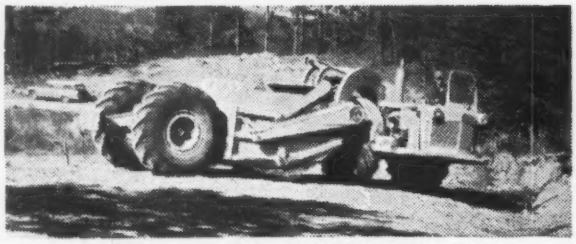

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Working of the Silt and Construction Material Directorate

By R. C. HOON

There is sufficient realization by now that the present-day investigational work, relating to the river development and flood control projects, should be carried out on a scientific basis so that the data, thus collected, affords the desired climate of confidence to engineers for designing and later constructing those projects. The Directorates of the Central Water and Power Commission, charged with planning and preparation of designs of projects, are at times called upon to carry out field investigations, surveys etc., of specific river development projects or flood control schemes by some States which lack the requisite technical personnel, facilities and know-how for such work. Those investigational surveys include such aspects as locating borrow areas for supply of appropriate types of soil material for use in construction of earth structures and quarries to serve as sources of aggregates suitable for use in mass construction in masonry of concrete, assessment of agri-irrigational potentialities of land commanded by the proposed irrigation projects, etc.

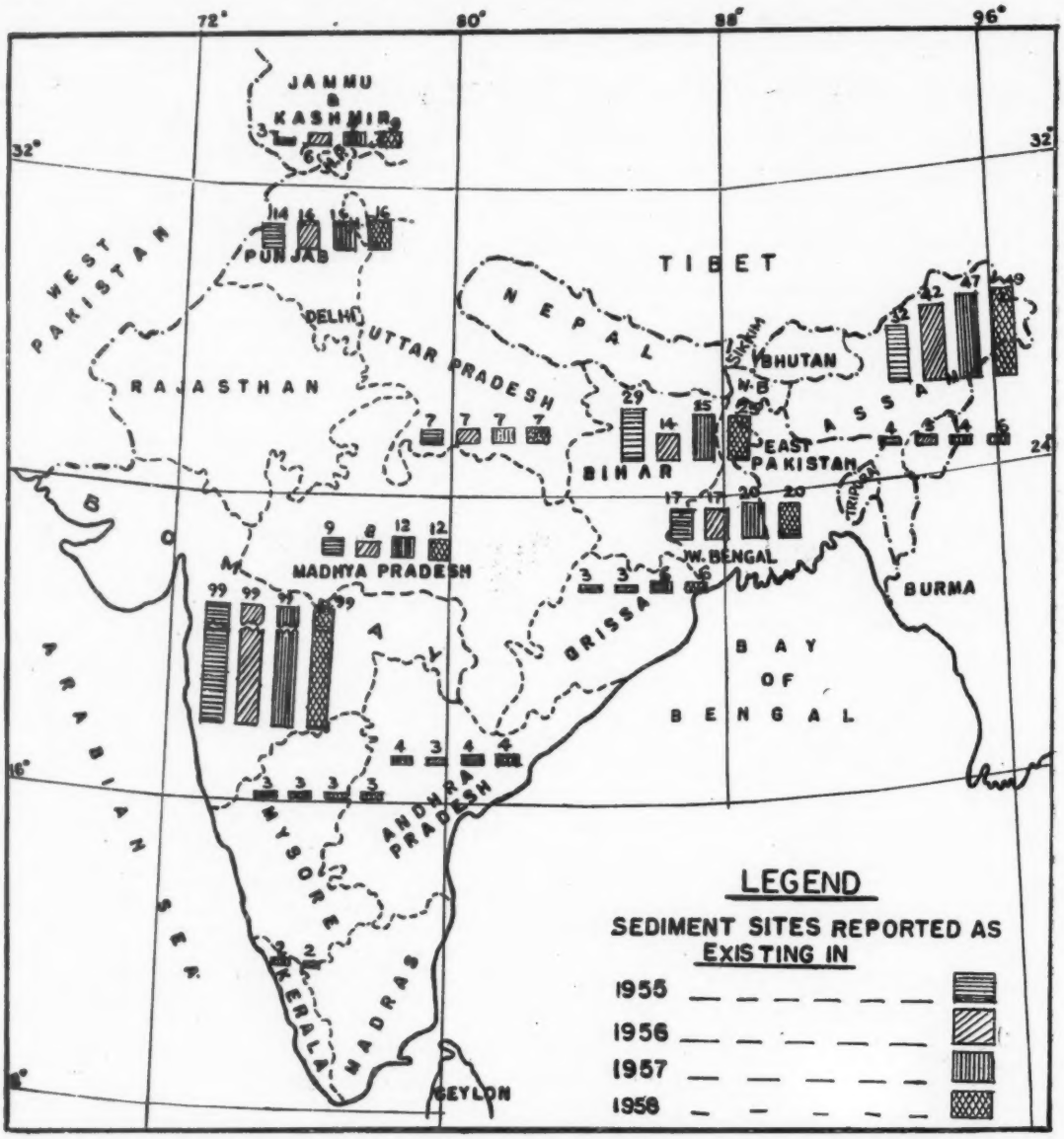
The forms of damage to engineering installations by silting up are manifold. The rivers have come to be regarded by agencies charged with the task of planning and designing river projects, as not only carrying water but sediment also. The sediment data pertaining to rivers, like their discharge data, has therefore come to be regarded as important in the design of the river development and flood control projects. The trend is now to design the new river projects and to improve the older ones with due consideration of the subsequent effect of sedimentation on their life and operation. However, the Commission, in their work relating to design and planning of projects realised that there was not only scanty sediment data available for the rivers in this country but, more often than not, that data was so dispersed among several States and that too not in a co-ordinated and compiled form, as to be unsuitable for purposes of reference. The need was thus obvious for coordinating and pooling all available sediment data of rivers. Even some of the specialists from other countries, who had been invited by the Government of India to advise on some aspects of our river valley projects and flood control schemes, stressed in their reports the urgent necessity of pooling the sediment data for the rivers in this country to ensure an easy access to it for reference as and when required. There was also need of further investigations to bring the field work relating to collection and estimation of sediment on more or less uniform and systematic lines to enable proper co-ordination and compilation of the sediment data so that it could be interpreted to the best advantage of the future projects.

The Central Water and Power Commission instituted the Silt and Construction Materials Directorate as part of the Flood Wing in December, 1954, to fulfil the above mentioned objectives i.e., to test and conduct researches on materials of construction, carry out field surveys and investigations, co-ordinate and compile the sediment data for the rivers of the country and carry out investigations and researches to improve the reliability of that sediment data. It was considered desirable for effective discharge of these functions that the Directorate should be located in Delhi along with the Designs and Planning Directorates of the Commission.

The Silt and Construction Material Directorate started functioning early in 1955 with two Sections only viz., the Soil Section, with facilities primarily for testing and undertaking special investigations relating to the use of soil as an engineering material and the Silt Section to undertake co-ordination and compilation of sediment data of rivers and practical work on related problems. The nature and quatum of work referred to the Directorate soon made it imperative to widen their scope of activities by instituting two more Sections viz., the Concrete and Materials Section and the Chemical and Soil Survey Section. The salient features of the work carried out by the four Sections of the Directorate are described Section-wise in the following paragraphs:-

Soil Mechanics Section

The Section is engaged on testing soils for their engineering properties for use in construction of earth dams, embankments etc. This particular aspect of work entails, in the case of some projects, carrying out of field investigations such as survey of borrow areas to locate soil materials conforming to design requirements, assessment of the quality and quantity of available soil material, examination of the condition of foundations either below existing structures or at sites where new or additional structures are proposed to be built, etc. Among the projects, for which such soil testing and/or field investigations have been undertaken, are included the Barna, Kolar, Ken, Damoh, Raigwan, Sagar, Bah, Tawa, Nagda Nallah, Sakar Nallah, Pareri, Dhanwandhar, Tardala and Maroda (Madhya Pradesh); Kosi (Bihar); Trisuli (Nepal); Arwar, Chambal and Kotah (Rajasthan); Wazirabad Weir (Delhi), Andaman Islands (C. P. W. D.; Badumara, Tillemaru and Nagarjunasagar (Andhra); Hirakud (Orissa), Sharavati (Mysore); Delhi International Airport (Union Health Ministry); Jamuna Rail-cum-Road Bridge (Northern Railway); Lighthouse Wing (Union Misnistry of Transport) etc. Soils have, in addition, been tested and investigation carried out for the States of Jammu and Kashmir, Punjab,



Plan 1. Map showing the existing sediment observation sites in the various States of India.

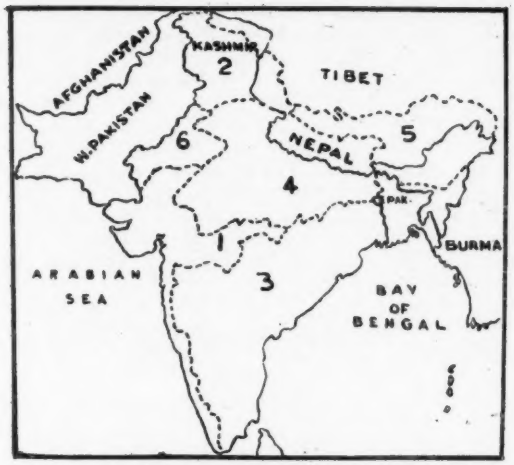
Kerala and from a number of non-Governmental agencies.

The Section assisted the Kosi Project in the establishment of some field laboratories and training the staff of those units for the quality control of compaction during construction of earth embankments there.

The Section has also been engaged in research on evolving some potential materials for use to protect flood works as alternative to stone at projects where the latter is not obtainable locally. Attempts have been directed at stabilising varieties of sands of different finenesses, and lighter soil materials with each of a variety of admixtures viz., cement with and without brick aggregate (jelly concrete), different grades of bitumen, lime with and without plaster of Paris etc. Among other special investigations undertaken by the Section have been the study into the causes of excessive leakage from water storage reservoirs, development of suitable clay grouts, simplified monograph for soil classification, suitability of different dispersing agents for use with calcareous soils, waterproofing of soils, etc.

Silt Investigation Section

This Section is engaged to co-ordinating and collating sediment data received from the States and Investigation Circles, of the various river



Plan 2. Showing the Hydrological Regions in India

systems in the country with a view to compile the same in a form suitable for reference when required. A persistent effort is under way to obtain that data from such sediment observation sites which though in operation, have failed to forward the same up till now. The procedure for co-ordinating and compiling sediment data comprises in expressing each of the coarse, medium and fine grades of the sediment, total sediment load and run-off for each day in terms of cubic-feet and acre-feet respectively; their cumulative totals are then worked out for each of ten-day, monthly and yearly (or part thereof, for which the site is in operation) basis.

It is a sad commentary that systematic sediment observations for a reasonable duration are only available for a very few rivers viz., the Mahanadi (Orissa), the Kosi (Bihar) and the Sutlej (Punjab). To the above may be added the Brahmaputra and its tributaries (Assam), the Godavari, Purna, Indravati and Wainganga (Andhra Pradesh), Narmada, Penganga and Wardha (Bombay), Bagmati, Kamla and Buri Gandak (Bihar) where observations have been started lately due to the efforts of the Commission mainly. The total number of sediment sites operating in the various States by the end of 1958, and based on the information received from the States, is 257 and their distribution is shown in Plan 1; that number is hardly sufficient to represent adequately the entire river system in the country. Moreover, apart from the paucity of sediment data, much of the utility of that data for reference is vitiated because of either the techniques of sampling, analysis etc., not being of a uniform pattern, or the inadequate location of observation sites on rivers, or sediment observations having been taken without reference to discharge of the river or without attempting to classify sediment into its grades, etc.

The Section has been attempting to bring about uniformity in sediment work by issuing adequate instruction with regard to collection and analysis of sediment samples and standardised proforma for recording sediment data on systematic lines are freely issued for use at obervation sites. Assistance is also afforded in the setting up of silt laboratories, procurement of special silt equipment and its standardisation and training the personnel for those laboratories.

Suggestions have been made with regard to sediment sites on such rivers where new river valley projects and flood control schemes are proposed to be constructed during the Second and subsequent Plan periods. To encourage the States to set up these additional sites, they have been assured of adequate loan assistance by the Commission if so required.

Apart from the work relating to co-ordination of sediment data, the Section is attending to related basic e.g., standardisation of the commonly used Punjab-type Bottle sampler in terms of relatively more standard samplers of the depth-integrating and and point-integrating types developed in other countries, locating sampling points to represent mean sediment concentration along vertical depth of rivers, weight: volume relationship of sediment etc. Plate 1 illustrates the simultaneous working of the Bottle sampler and the Point-integrating sampler (Turbudisonde L-80 evolved by the Neyrpic Laboratories France) on the Jamuna river for purposes of standardisation.

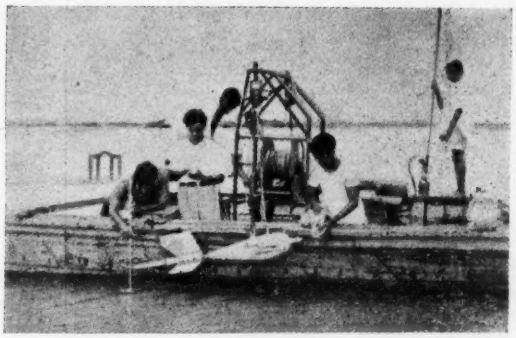


Plate 1

The Section is attempting to organise the survey of sediment deposited along the bed of rivers, and carries out the analysis of bed material samples for such agencies, as lack the requisite equipment and know-how, by issuing necessary instructions and affording training to staff to carry out that type of work. These studies of the bed material characteristics are important from the point of view of degradation and aggradation along rivers protected by embankments.

Among some of the interesting observation brought out as the result of co-ordination of sediment data are, firstly, that the magnitude of sediment load and run-off are not necessarily proportional; for instance, though the Brahamaputra has the maximum run-off, it does not have the maximum sediment concentration.

Secondly, while the Nagda Nallah, a minor tributary of the Ganga and Tamur, a tributary of the Kosi, have conspicuously high content of coarse grade sediment, the Godavari and its tributaries Purna and Wardha, on the other hand, carry a very high content of fine sediment. Thirdly, while the rivers in Basin 4, (Plate 2) having their source in the Great Himalayan Ranges, bring down a higher percentage of coarser grade of sediment, those included in Basin 3 in the South have relatively a much higher percentage concentration of fine-grade sediment.

Concrete and Materials Sections

This Section under takes testing aggregates materials for their suitability for use in cement and concrete and masonry construction and design concrete mixes from aggregate materials obtainable from local sources for those projects as request for such assistance. Among the projects for which work has been undertaken by the Section are Sagar and Bah (Madhya Pradesh), Trisuli (Nepal), Tripura Investigation Division, Wazirbad Weir (Delhi).

Special investigations undertaken by this Section comprise determination of tensile strength of brick masonry blicks built in different cement mortar mixes (Plate 2), strength characteristicks of set concrete blocks removed from apparently defective works,

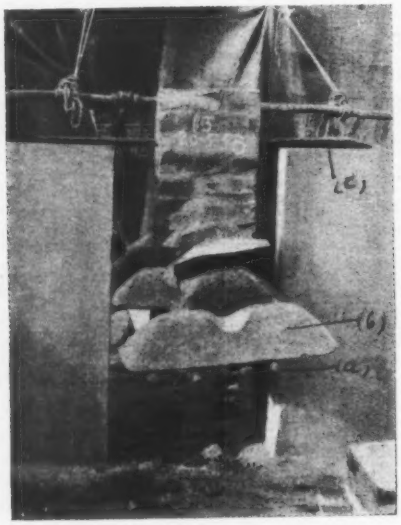


Plate 2

suitability of water-proofing compounds, etc. Interesting results have been obtained from the study to assess the deleterious effect of mica contained in fine aggregate in mortar and concrete undertaken with special reference to the construction of the Kosi Barrage. The Section has been engaged in research on subjects such as the influence of finer fractions in sand on properties of cement concrete mixes, vacum processed concrete, effect of grading of aggregates on the characteristics of cement concrete, stabilisation of light-textured soil with lime by autoclaving etc.

Chemical and Soil Survey Section

The Section assists such Projects as request for soil surveys of land to come under the command of proposed controlled irrigation systems, by undertaking the field work and/or testing of soil and water samples collected during such surveys with the purpose of assessing the agri-irrigational potentialities of such land. Alternatively, the Projects, on their part, arrange to complete the field work, and the soil and water samples collected by them are tested in this Section on the basis of which reports are prepared. Projects for which this type of work has been done by the Directorate include the Kasyari, Ken, Unchera, Nagda Nallah, Pareri, Raigon, Bah, Sagar, and Hallali (Madhya Pradesh), Koplli (Assam).

The Section undertakes the chemical analysis of varied materials viz., soils, cement, limes, etc., arising out of work in the Soil and Concrete and Materials Sections. The Section has tested a very large number of set mortars and concrete samples, as were referred to the Directorate by various Committees, agencies etc., to determine the proportions of various constituents of those mixes. The chemical analysis of water samples has also been done for a number of projects to report on their suitability for irrigation purposes.

An important aspect on which special investigation has been in progress relates to the fertilising characteristics of silt carried in suspension in river waters that finds its way to the cultivable land during flooding of otherwise with irrigation water.

Restriction of Evaporation Losses from open storage and of seepage losses from irrigation channels

As a result of the consideration of the report of the Delegation, which was sponsored by the Governmen of India and which visited Australia in 1956, it devolved on the Commission to get well-planned laboratory and field experiments at (*a*) selected sites in Madras, Mysore and the Punjab on the use of Cetyl alcohol monolayer for restricting evaporation losses from open water storages and (*b*) at the Research Stations in Poona and Amritsar to investigate the possibility and economics of adopting the plastic film as lining material to reduce seepage losses from irrigation channels. The Directorate undertook these assignments for the Commission. The field experiments relating to the use of Cetyl alcohol are being carried out by the Directorate at a water storage tank near Faridabad (Punjab) and a liaison is being maintained with similar experiments being carried out in Madras and Mysore States. Some laboratory experiments are also in progress at the Directorate laboratories on the plastic film apart from the full-scale experiments being done by the two other Research Stations.

Programme of Basic Research

The Directorate has been allotted the following problems in connection with the programme of basic research of the Central Board of Irrigation and Power :—

[*Continued on page* 8

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Dunlop conveyor belting at the Bhakra Nangal Dam.

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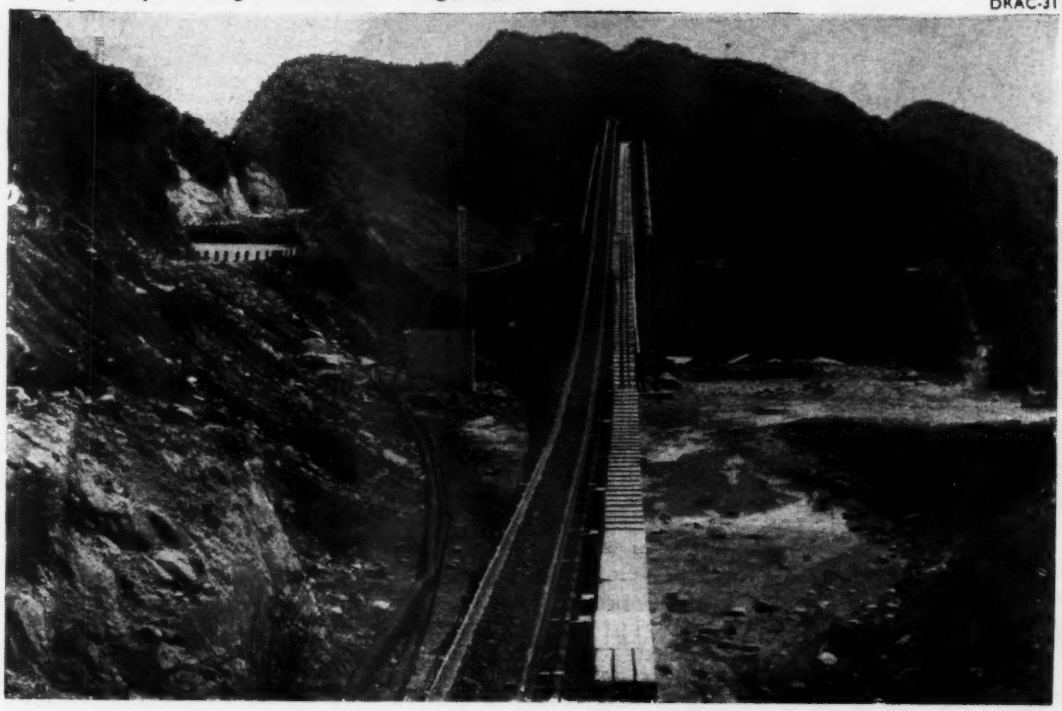

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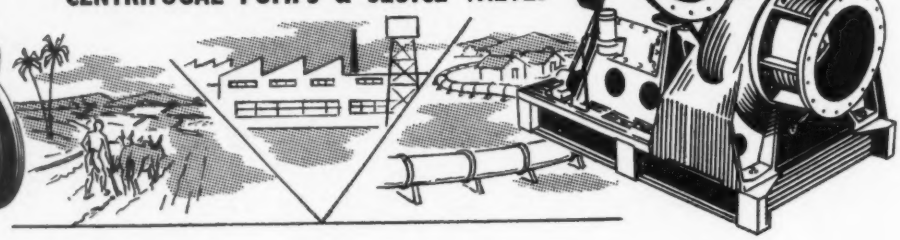

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Sub-surface Drainage and Irrigation: Trend in East European Countries

By R. D. DHIR

With the growth of population of a country, such as in India, there is a clamour for increased irrigation facilities and fresh land to be brought under irrigation. In providing water supplies depending upon the natural flow of the rivers, the scope is soon exhausted and the creation of artificial lakes by damming up rivers and streams becomes imperative. These lakes and irrigation canals at higher contours of the land bring in their wake, among other problems, the problem of land drainage. The ground-water table rises in the neighbourhood of these reservoirs and canals, be they for any purpose, such as irrigation, flood control etc. The rise of water-table at lower contours may assume such serious proportions as to establish water-logged conditions. This will render lands which were formerly cultivable, unfit for cultivation unless adequate drainage arrangements are made to lower the ground water-table.

Although irrigation has been practised in India since ancient times, the problem of drainage does not appear to have received adequate attention until recently when the conditions of water logging and "*thur*" have become alarming. The States of Punjab and U.P. paid relatively more attention to these problems but even in these States, the attempts made were more or less for meeting the pressing demands of local situations as and when they arose. As these undesirable consequences of intensive irrigation are becoming more acute, the problems of drainage are gaining a greater and country-wide attention. The rapid progress in implementation of schemes in the National Plans is likely to spread the undesirable consequences of water-logging to a wider area, and as such the question of providing drainage particularly in areas which are in consequence likely to become water logged, is assuming sufficient importance for the drainage facilities to be considered as an integral part of the irrigation and other such projects under construction. At the same time special schemes for reclaiming the water-logged and *thur* lands are under consideration.

For reclamation of water-logged areas, the commonly adopted practice in India is the construction of a system of open drains for affecting sub-surface drainage. Sometimes the drains are made up of tiles placed below ground surface. The present popularity of open drains is understandable in the context availability of cheap labour and non-availability of highly mechanised units of construction. But in its ultimate content, it does not lead to good land economy. Open drains occupy some portion of the surface area of the land to be reclaimed, and this results in waste of useful land. The section of the drains, though relatively narrow at the bottom, have top widths frequently upto 20 to 25 feet, because of the requirements of flat side-slopes for the drains. In India, this wasteful aspect of surface drains has not perhaps been reckoned serious until now. However, in the prevailing agricultural economy of the country with its growing population and pressure on land, the loss cannot be ignored so lightly.

Thus it is important that the current drainage practice in India should be improved to minimise the loss of land as much as possible. In this field, the work done in the East European countries and particularly in Czechoslovakia and East Germany in evolving an improved technique in subsurface drainage will be of considerable interest.

The object of sub-surface drainage is to reclaim water-logged areas by drains constructed at suitable depths below the ground level, with the least loss of cultivable land surface. It would be enough if the watertable is depressed to 4 feet below the ground level, for most of the crops to grow. The traditional tile drainage system is liable to get choked, as the vertical joints of the tile drains encourage root growth and siltation. Despite the comparative cheapness of the pipe material, the construction of drains by manual labour is slow and the practice has been rightly considered messy and dirty. In an attempt to minimise the above defects, the present trend is to accomplish it by mechanising the pipe-laying work.

The normal practice in Europe is what is called the "Mole drainage system". The pipe-laying unit consists of a machine pulled by a tractor followed by two small mechanical units, the first one being a vertical steel plate about 4 feet long, 4" wide and 0.2" thick with a cutting edge in front; and the second, a mole-plough pulled by a chain behind the steel plate. The plate makes a cut in the ground about 4 ft.deep. There is an automatic arrangement for making the bottom of this cut to be laid at a regular pre-determined slope, irrespective of small undulations of the ground surface. The pipe-laying work is mechanised to some extent, by the mole plough. The pipe is not moulded to the required shape and size at the place where it is to be laid. The prepared pipe is dragged by the mole plough along the trench and laid in position. The drains thus constructed are called mole drains and are more efficient than the tile drains which to date constitute the conventional method of drainage in India.

Considerable interest is being evinced in Czechoslovakia and Germany for attaining as much of mechanisation as possible in drainage work. The importance attached to drainage work has a bearing on the agricultural economies of these countries. For in-

Plate 1. An underground pipe line, newly laid by the Rohrpflug machine. Drainage is in action. The pipe discharging into a main drain can be seen in the centre foreground.

stance, nearly one tenth of the farm land in Czechoslovakia has drainage works i. e. in areas aggregating to 800,000 hectares (19, 76, 880 acres). Of this drained area, 500,000 hectares (12,35,550 acres) are drained by underground tile drains and the remaining 300,000 hectares (7,41,330 acres) by surface drains.

As a result of researches conducted at the Institute of Soil Science and Soil Conservation, Griefswald, University in East Berlin, Professor Janert has patented a machine named 'Rohrpflug' for constructing sub-surface drainage system with pipes of a thermoplastic material. Some disadvantages were noticed in the pipe system constructed by the mole plough. The dragging operation of the pipes made them liable to be scratched, thereby damaging the protective coating of shellac used for them. And the longitudinal groove in the pipe did not always retain its position at the bottom of the pipe line, but turned sideways or even through half a circle so that the open groove appeared at the top. It is very necessary that the groove is at the bottom of the pipe for the drainage system to function properly. The Rohrpflug machine is an improvement over the mole plough machine and has made an important and interesting development in sub-surface drainage practice. Its practical use is of topical significance to the reclamation of millions of acres of water-logged lands in India. The manufacture of the machine, at the present moment, is under-

Plate 2. The Rohrpflug machine at work in the field. It moves along the chosen line, excavating the trench and laying the pipe.

taken by Diedrich Halmche, Horneburg, N.E.D.B.R. (West Germany).

The Rohrpflug machine is similar to the mole plough machine except for an important change, by which the mole plough principle is abandoned and another unit with a tool very much like a grooving plane is substituted. This unit is called the "digging plane" and works in the following manner:

*The digging plane which has a width of 17 cm (6.7″), is guided by a square beam attached to a rigid frame in such a way that the pipe-forming guide operates almost in the centre of gravity between the tracts and the rear wheels of the machine. As the plane moves slowly forward, a narrow trench is opened up to a pre-determined depth by means of a diopter and sighting bars, and is regulated by an electric motor with alternating gears. The soil cut on the surface by a disc and lifted up by the plane turns to both sides and falls back into place behind the passing machine, thus refilling the trench automatically. Meanwhile, the process of pipe-forming and laying goes on continuously. Thermoplastic material which is cut into strips of 30 cm (5.1″) wide are used for moulding the pipes in position. The ends of the strips are connected by special punching machines to an endless strip which passes through a forming guide paced at the bottom of the digging plane. This material runs off a magazine drum at a speed equal to that of the machine, namely, 16′ per minute right through the hollow digging plane. The material on its way, gets electrically heated by infra-red radiator to a temperacure suitable to make it plastic. The lower portion of the digging plane contains a compartment in which the pipe-forming mechanism is housed including the pipe-forming mandrel. The moulding of the plastic material to a circular tube is accomplished by four rolls, two of which press the foil on to the mandrel from above while the other two are in vertical position and press the foil sideways against the mandrel. The final pipe form as moulded is in the shape as shown in Fig. 1.

*"The Completely Mechanised Construction of Drainage and Sub-irrigation Systems" by Dr. H. Janert, Greifswald.

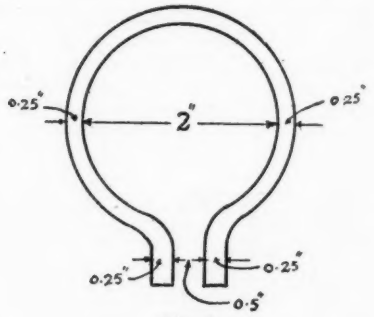

Fig. 1

One of the edges forming the longitudinal groove is toothed, which is done by a little punching machine placed behind the magazine drum as the strip passes through, on its way to the pipe-forming mechanism. When leaving it again, the heated pipe material is cooled down immediately as it gets covered with the soil loosened from the vartical walls of the trench by steel prongs attached to the back of the digging plane. A two-piece pressure roll compresses the loose soil material from both the sides of the pipe and packs the line in its final position. The entire work of construction of the pipe system is fully mechanized and it leaves the surface of the ground with very little damage.

There are many advantages obtained in this method of construction of pipe-lines with the thermo-plastic material for pipes. The cost of the drainage system is considerably lowered by a fuller mechanisation and by substituting a more suitable pipe material. The transport charges are also reduced as the quantity of thermo-plastic material required is small, only about hundred grams per meter of pipeline. The quality of mechanically constructed drains is decidedly improved as compared with ordinary drains, which consist of individual short tiles liable to dislocation. The new drains maintain their alignment even if some settlement takes place in the soils. Another important advantage is that the drains are not exposed to the dangers of root growth and siltation as there are no verticle joints unlike those in the ordinary tile drains. Further, it is ensured that the longitudinal groove is always maintained at the bottom of the pipeline in the most favourable hydraulic position.

The mechanically constructed drains of thermo-plastic material, have been tested in an experimental drainage field near Greifwaled and the results have been compared with those obtained in a system of ordinary tile drains, also laid in the neighbourhood under similar drainage conditions. The thermo-plastic drains were laid at intervals of 8.00 meters and .60 meters deep while the tile drains were laid at intervals of 13.3 meters and at a depth one meter. The former system proved much more efficient in completing its task of drainage only after 9 days of its installation, while the tile drainage kept on working though the whole month.

The tile drainage system requires a deeper soil cover cushion to prevent any damage to the tiles by crushing. Obviously, it necessitates the drainage system to work at lower depth than is possible with the mechanically constructed drains. Thereby, the latter system scores over the former in a very important feature since it effects drainage only to the required depth of the soil strata and conserving water at a lower depth. In this manner, the mechanically constructed drains, permit speedier reclamation of the land for cultivation and also retention of soil moisture at a slightly lower depth within the capillary reach of the plants to stand dry periods in summer. On the other hand, the tile drains are required to be buried deeper on account of their structural fragility and it imposes on them a heavier, unwanted and even harmful drainage load.

There is no loss of valuable cultivable land in the subsurface drainage system. Almost the entire surface of the land is reclaimed. Apart from the fact that the drains are not liable to root growth and silt creep through the vertical joints, they cannot either get choked by soil getting into the pipe since it is ensured that the line of open edge is at the bottom, pointing always downwards. The pipeline can be laid at a regular slope which can be adjusted and fixed as predetermined.

In a demonstration of the mechanised construction of the work of laying the thermo-plastic pipe drain and its working, it was observed that the drain discharge started coming out of the pipe line in about 20 minutes after the pipes were laid. The construction was rapid and the results were found to be satisfactory. The diameter of the pipe laid was 3.3 cm. The tractor used was of only 9 horse power. This horse power is rather low and efforts are being made to raise its power which will reduce the strain on gears. As at present developed, the speed of laying these pipes is about 300 to 360 meters per hour or 0.2 miles hr. The normal drain-discharge obtained is 0.6 litres per second per hectare or 0.08 cusec per acre. But under the most favourable conditions, the discharge can reach as high as 0.9 liters per sec. per hectare or 0.11 cusec per acre.

So far, on an experimental basis, 20 hectares or 49.42 acres have been reclaimed with this machine. The cost is 0.3 marks per meter of drain or Rs. 0.1 per foot run of drain. Generally, on an average, one kilometer of drain is required for one hectare if the drains are spaced 10 meters apart. In F. P. S. units, this would mean that 1324 feet of drain is required per acre if the drains are spaced 33 feet apart. The life of pipe drains has not yet been determined but it is estimated that they would last for more than three years.

It is considered that the current drainage practice in India may be improved by adopting as far as possible the mechanised unit for sub-surface drainage. Though the saving of manual labour is not of much significance, the speed of construction is of great importance in the context of the progress already made on irrigation and other projects with no corresponding drainage schemes. There is a necessity of the drainage schemes catching up with the irrigation and other

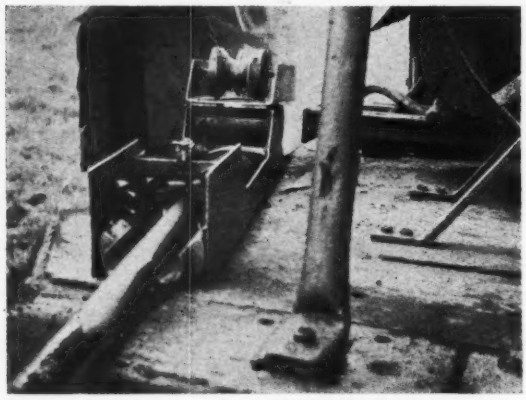

Plate 3. These two insets show close-up views of the mechanism which moulds the strips of thermoplastic material into pipe-forms. It combines the operations of heating the material by infra-red radiator to make it plastic and moulding it into the final form of drain lining (pipe-form).

schemes, which are liable to add water to the sub-soil. In future the German adage, "No irrigation without drainage" has to be remembered at the time of framing irrigation schemes and soil surveys must be carried out to decide if the irrigation scheme should be accompanied by a drainage scheme as an integral part of it.

The complete mechanisation of the work of pipe-laying, thereby lowering the cost of sub-surface pipe system, paves the way for its application in sub-surface irrigation. It is well-known that among the various methods of supplying irrigation water, sub-surface irrigation is undoubtedly the most effective in the matter of water conservation and a rewarding harvest for agricultural labour expended. It saves water by almost completely avoiding unproductive evaporation losses. The other advantages of the sub-surface irrigation are that it leaves the surface soil in favourable condition; weeds and plant diseases are held in check; the management of soil and crops is in no way obstructed by furrows, field channels or any other obstacle; finally, subsurface-irrigation can be made to operate automatically, when it is properly installed.

In spite of the above advantages, surface irrigation is more extensively used because it has been in practice for a long time and found to be cheaper and offering greater ease of operation than sub-surface irrigation. Moreover, sub-surface irrigation involves some skilled installation and technique of operation. It also requires the construction of pipe systems in the soil with extremely narrow spacing in order that the water may be distributed properly and evenly over the entire area bearing the crop. This makes the system prohibitively expensive as compared to surface irrigation. Climate and soil conditions have a great influence on the efficiency of sub-surface irrigation. Also, the system has no practical use when the water-supply available is silty as the pipes soon choke up with silt. It is eminently suited to be employed in the case of tubwell irrigation wherein the high cost of water demands every means of its economical use. These factors place a limit on the application of sub-surface irrigation to suitable areas only.

The concept of sub-surface irrigation may be considered to an extent as a reverse process of water flow to that of sub-surface drainage. Instead of allowing

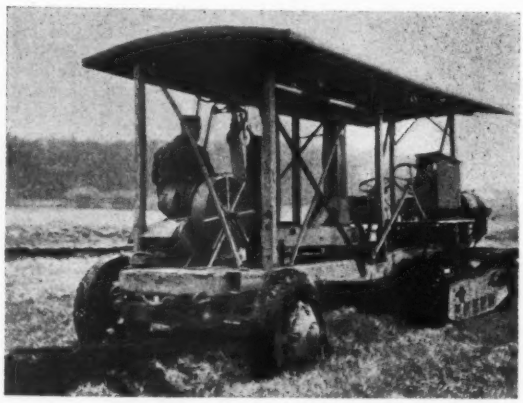

Plate 4. Picture shows a general view of the new Rohrpflug machine devised in East Germany. The machine is an assembly of different units which, in a combine, accomplishes the several operations of excavating trench to the required grade, moulding strips of thermoplastic material into pipe-forms, laying them in position and finally refilling the trench. It is an improvement over the Mole Plough machine and an important addition to the existing equipment of plant and machinery at the service of engineers, opening out new possibilities in sub-surface drainage and irrigation practice.

the pipe system to drain away the unwanted water from the soil in reclaiming water-logged area, sub-surface irrigation pipe system supplies the water requirements of crops. It is, therefore, enough if the pipe lines reach the water near the ground surface and the actual distribution of the water in the soil occurs by the phenomenon of capillary action of the soil structure. The fact that sub-surface irrigation depends upon the utilization of the capillary forces, limits the practice to lands of suitable soils. If the capillary action is not sufficient as for example, in gravel, course sand, or in impermeable clay, the results of sub-surface irrigation would be unsatisfactory. Medium soils, fine sands, sandy loam and loam show the most favourable conditions. Even in these soils, the capillarity of the soils may get spoiled by incorrect management. This occurs with certainty, when the soil is exposed to the influence of surplus water. As soon as the whole pore space of the soil is filled with water, the soil structure is in danger of being destroyed, a process which begins with the soil particles gradually becoming dispersed. The supply of water from the pipelines into the soil should therefore not be more than what is required for the crops. It is of foremost importance that the soil is not subjected to an application of water under pressure. The pipe system must be constructed in such a manner as to ensure this requisite condition. To this end, the pipelines should be constructed with sufficient slope to avoid any danger of obstruction to the water flow inside the pipe system. Further, these pipelines must not be run full but the supply should be in small quantities, trickling along the bottom of the pipes. As long as the soil does not get saturated to its full capillary capacity, it takes up water through the longitudinal grooves and this up-take of water ceases if the point of saturation is reached.

In a practical test conducted for determining the working of the system, the following behaviour of the movement of soil-moisture was observed.

The distribution of water in the soil when supplied from a pipeline under no pressure takes place mainly in a certain horizon distinguished by the highest biological activity which generally coincides with the highest capillarity. If, however, the pipeline is set under pressure, as a trial, the characteristic apparance of water distribution is entirely changed. Here, the tendency of water movement is distinctly downward which is due to the effect of over-strained cappillarity of the soil. This leads to bad results of irrigation and to heavy losses of water by percolation into deeper underground layers. The sub-surface irrigation also shows the most favourable results with a maximum water content at a depth, of 40 cms or 16".

The sub-surface irrigation has been practised to a limited extent, but the acreage brought under such irrigation is negligible when compared to the area under surface irrigation. But wherever the sub-surface irrigation has been adopted, the results have been highly remunerative in respect of produce in relation to the quantity of water used. The main reason for the limited application of this method has been the high cost of laying the pipelines. The present trend of completely mechanized construction of pipelines coupled with introduction of a cheap thermoplastic pipe material would probably pave the way for an extensive application of sub-surface irrigation. However, one important aspect, namely whether the salinity of the soil has an adverse effect on the spacing of the pipes as well as on the effectiveness of the distribution of water, has not yet been studied. This is engaging the attention of research workers in Russia. The results would indicate whethere the field of application of sub-surface irrigation can be extended to saline soils.

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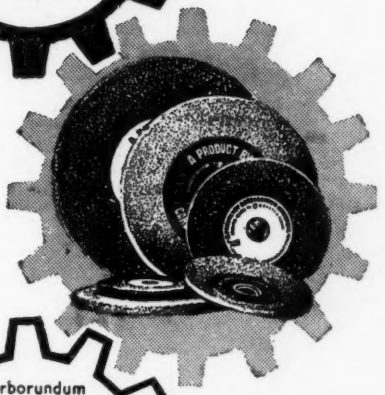

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PSIP 6

A Sampling Approach to the Estimation of Floods

By P. R. AHUJA
and K. C. MAJUMDAR

As calculated risk in different civil engineering works like bridges, barrages, weirs and dams has to be taken consistent with economy, the estimation of floods for different recurrence intervals for which these structures have to be designed, plays an important part in the field of hydrology. The main handicap in evolving a generalised method for the purpose lies in the inadequacy of number of years of annual peak flood data. For most of the rivers in India as well as in many parts of the world, data more than 20-30 years is rarely available. An estimation of floods for return period greater than 100 years based on such a few years' data has its own limitations.

Lee (1956), Moran (1957) and several others have investigated this feature and tried to throw light on the optimum number of years on which analysis should be based. Rowe, Long and Royce (1957) adopted regional synthesis techniques for obtaining flood frequencies by amalgamating the flood records of several rivers having similar characteristics in order to multiply the number of years of data. Langbein (1949) and Chow (1950) have advocated analysis on partial duration series when data are not available for more than 10 years.

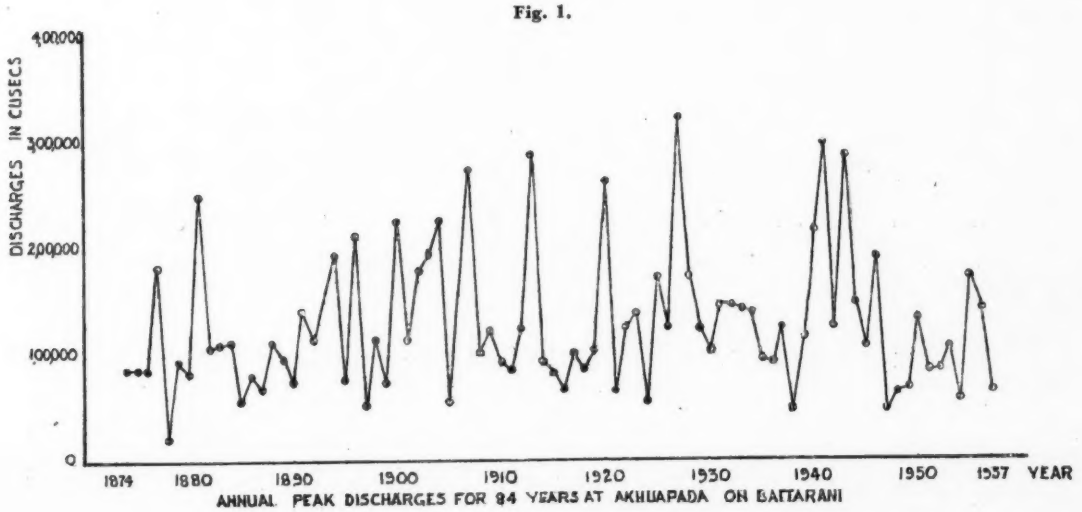
The purpose of the present study is to investigate the effect of different sub-samples of same number of years of data on the estimation of annual peak flood and to arrive at a more appropriate estimate based on the combined effect of different sub-samples, drawn from the available set of records. In practice in is not known which of the sub-samples will lead to the better estimate of flood of different return period, but according to statistical principles the average of the various estimates from different sub-samples will be nearer to the central value.

Data and Sub-Samples

The present method has been developed with 84 years' data recorded from 1874 to 1957 on Baitarani at Akhuapada in Orissa. The river rises in Chotanagpur hills in Bihar and falls into Bay of Bengal coursing its way through eastern part of Orissa. Akhuapada is situated at the head of the river delta and the Baitarani has a catchment area of about 4000 sq. miles. The mean annual rainfall in the catchment area is 53.58 inches and the runoff 5.9 million acre feet. There is a proposal to construct a dam across the Baitarani at Bhimkund for generation of hydel power and providing irrigation in the lower catchment of the river. The results of this study has no bearing on the investigation in respect of the Bhimkumd project, but is purely of theoretical interest.

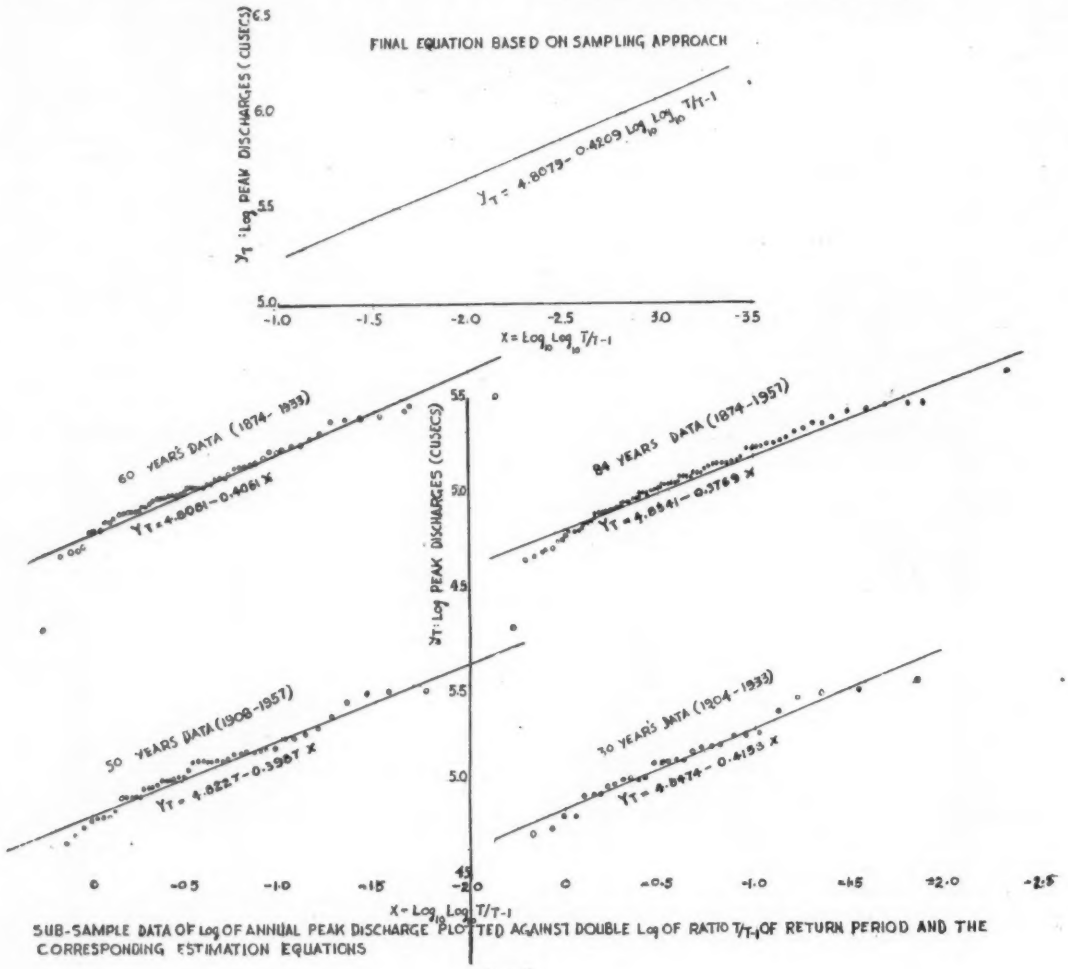
Most of the data are recorded in the report on occurrence of floods in the Orissa delta by Prof. P. D. Mahalanobis. The annual peak discharge values are obtained from the office of Hirakud Dam Project. These are said to have been worked out by utilising a relation between the concurrent gauge discharge observations for the years 1896 and 1920 given in the said report. These annual peak discharges are given in Table I. These are also shown graphically in Fig. 1

Fig. 1.



ANNUAL PEAK DISCHARGES FOR 84 YEARS AT AKHUAPADA ON BAITARANI

Sub-samples of 10,15,20,30,40,50,60,70 consecutive years are drawn out of the total of 84 years' observations, both starting from the beginning (i.e., from the year 1874) and also from the end (i.e., from the year 1957). When the available series of data is short additional sub-samples may be obtained by taking a few more random start, say for example, with the 3rd, 4th or 5th year from the beginning or end. Number of sub-samples considered here are 16 for sample size of 10 years, and 10 8, 6, 4, 4, 2, 2, 2, and 1 respectively for sample sizes of 15, 20, 25, 30, 40, 50, 60, 70 and 84 years. A few of these 55 sub-samples are plotted against their respective plotting positions on a double long scale, as shown in Fig. 2.



SUB-SAMPLE DATA OF Log OF ANNUAL PEAK DISCHARGE PLOTTED AGAINST DOUBLE Log OF RATIO $T/T-1$ OF RETURN PERIOD AND THE CORRESPONDING ESTIMATION EQUATIONS

Fig. 2.

Method of Analysis

There are quite a few methods of analysing the frequency of occurrence of annual peak discharges. Foster (1924) has used Pearson's type III equation and Beard (1952) has produced simplified tables from which flood magnitude for different return periods can be derived after calculating the co-efficient of skewness. Chow (1953) has advocated the use of the Gumbel's (1941) equation which is based on sound statistical theory due to Fisher and Tippett (1928). Recently, Chow (1954) has put forward log-normal distribution which is, according to him, the most appropriate frequency equation but its use is subjected to suitable adjustment for coefficient of variation and coefficient of skewness. Thus the most generalised equation suitable for all river data is yet to be known. In this study, we have, therefore, preferred to use Gumbel's theoretical equation as modified by Chow using logarithms of the peak discharge values. These logarithms are given in Col. 4 of Table I.

The theoretical equation for the estimation of maximum peak flood is given by:

$$Y_T = \alpha + \beta \log_{10} \log_{10} \frac{T}{T-1} \quad \ldots\ldots\ldots\ldots (1)$$

where,

T=return period in years.

Y_T=flood magnitade corresponding to the return period, T. The plotting position for the observed Y_m value is given by

$$T_m = \frac{n+1}{m} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

where '*m*' is the rank of the observed discharges arranged in decreasing order of magnitudes and '*n*' is the number of years of data. For example, in case of sub-sample of 10 consecutive years' data, '*n*' is 10, and '*m*' takes the values from 1 to 10 and so on. Using observed values of Y_T and the corresponding values of T from the formula (2) of plotting position the perameters α and β in equation (1) are determined by the method of least squares. These are given in Table 2. Equations corresponding to a few sub-samples of different sizes are shown in Fig. 2.

Table 1.

Maximum annual peak gauge and discharges at Akhuapada on Baitarani

S.No.	*Year*	*Gauge in Ft.*	*Discharges in Cusecs.*	*Logarithm of discharges.*
1	2	3	4	5
1.	1874	60.50	87000	4.940
2.	75	60.50	87000	4.940
3.	76	60.00	85000	4.929
4.	77	64.40	183000	5.262
5.	78	56.60	20000	4.301
6.	79	60.50	95000	4.978
7.	80	59.90	83000	4.919
8.	81	66.60	250000	5.398
9.	82	61.20	108000	5.033
10.	83	61.30	110000	5.041
11.	84	61.40	112000	5.049
12.	85	58.30	54000	4.732
13.	86	59.70	80000	4.903
14.	87	59.10	68000	4.833
15.	88	61.40	112000	5.049
16.	89	60.70	98000	4.991
17.	90	59.30	72000	4.857
18.	91	62.70	142000	5.152
19.	92	61.40	112000	5.049
20.	93	63.30	156000	5.193
21.	94	64.80	195000	5.290
22.	95	59.45	75000	4.875
23.	96	65.46	211000	5.324
24.	97	58.10	50000	4.699
25.	98	61.65	116000	5.064
26.	99	59.30	72000	4.857
27.	1900	66.00	228000	5.358
28.	01	61.50	114000	5.057
29.	02	64.30	180000	5.255
30.	03	60.60	96000	4.982
31.	04	66.00	228000	5.358
32.	05	58.40	56000	4.748
33.	06	63.90	172000	5.236
34.	07	67.20	275000	5.439
35.	08	60.80	101000	5.004
36.	09	61.90	122500	5.088
37.	10	60.60	96000	4.982
38.	11	59.80	82000	4.914
39.	12	62.00	125000	5.097
40.	13	67.60	290000	5.462
41.	14	60.40	92500	4.966
42.	15	59.90	83000	4.919
43.	16	58.90	65000	4.813
44.	17	60.80	101000	5.004
45.	18	60.00	85000	4.929
46.	19	60.80	101000	5.004
47.	20	66.90	263000	5.420
48.	21	58.90	65000	4.813
49.	22	62.10	127000	5.104
50.	23	62.60	140000	5.146
51.	24	58.20	52500	4.720
52.	25	64.00	173000	5.238
53.	26	62,00	125000	5.097
54.	27	68.30	325000	5.512
55.	28	63.90	172000	5.236
56.	29	62.00	125000	5.097
57.	30	60.90	102500	5.011
58.	31	63.00	148000	5.170
59.	32	62.90	146000	5.164
60.	33	62.70	142000	5.152
61.	34	62.60	140000	5.146
62.	35	60.50	95000	4.978
63.	36	60.30	91000	4.959
64.	37	62.10	127000	5.104
65.	38	57.90	47500	4.677
66.	39	61.60	117000	5.068
67.	40	65.60	217000	5.336
68.	41	67.80	300000	5.477
69.	42	62.10	127000	5.104
70.	43	67.50	287000	5.458
71.	44	63.00	148000	5.170
72.	45	61.20	108000	5.033
73.	46	64.70	192000	5.283
74.	47	57.80	45000	4.653
75.	48	58.80	64000	4.806
76.	49	59.10	69000	4.839
77.	50	62,40	134000	5.127
78.	51	59.90	83000	4.919
79.	52	60.20	84000	4.924
80.	53	61.20	108000	5.033
81.	54	58.50	58000	4.763
82.	55	64.10	175000	5.243
83.	56	62.70	142000	5.152
84.	1957	58.70	62000	4.792

Table 2.

Estimation equations of log peak discharge from different sub-sample data at Akhuapada on Baitarani. Only the values of the Parameters of the estimation equation viz., $Y_T = \alpha + \beta \log_{10} \log_{10} T/T-1$, are given. Y_T = logarithm of annual peak discharge (cusecs), T is the corresponding return period in years.

S. No.	*Sub-sample size (No. of years of data in the sub-sample)*	*Years considered in the sub-sample.*	*Parameters of the estimation equations.* α	β	*Average value of parameters of all sub-samples of same size.* α	β
0	1	2	3	4	5	6
1.	10	1874 - 1883	4.6489	-0.5633		
2.	,,	1884 - 1893	4.7933	-0.3248		
3.	,,	1894 - 1903	4.7905	-0.4947		
4.	,,	1904 - 1913	4.8275	-0.5288		
5.	,,	1914 - 1923	4.7811	-0.3996	4.7871	— 0.4594
6.	,,	1924 - 1933	4.8995	-0.4161		
7.	,,	1934 - 1943	4.8217	-0.5352		
8.	,,	1944 - 1953	4.7335	-0.4248		
9.	,,	1948 - 1957	4.7388	-0.3829		
10.	,,	1938 - 1947	2.7694	-0.6176		
11.	,,	1928 - 1937	4.9876	-0.1976		
12.	,,	1918 - 1927	4.7714	-0.5663		
13.	,,	1908 - 1917	4.8110	-0.3705		
14.	,,	1898 - 1907	4.8431	-0.5063		
15.	,,	1888 - 1897	4.7913	-0.4444		
16.	,,	1878 - 1887	4.5857	-0.5768		
1.	15	1874 - 1888	4.6806	-0.4671		
2.	,,	1889 - 1903	4.8263	-0.4113		
3.	,,	1904 - 1918	4.7922	-0.4645		
4.	,,	1919 - 1933	4.8840	-0.4131	4.7974	-0.4478
5.	,,	1934 - 1948	4.7765	-0.5249		
6.	,,	1943 - 1957	4.7285	-0.4864		
7.	,,	1928 - 1942	4.8982	-0.3653		
8.	,,	1913 - 1927	4.7718	-0.5210		
9.	,,	1898 - 1912	4.8486	-0.4228		
10.	,,	1883 - 1897	4.7677	-0.4015		
1.	20	1874 - 1893	4.7325	0.4156		
2.	,,	1894 - 1913	4.8312	-0.4636		
3.	,,	1914 - 1933	4.8367	-0.4056		
4.	,,	1934 - 1953	4.7789	-0.4678	4.7913	0.4429
5.	,,	1938 - 1957	4.7431	-0.5084		
6.	,,	1918 - 1937	4.8807	-0.3719		
7.	,,	1898 - 1917	4.8269	-0.4296		
8.	,,	1878 - 1897	4.7001	-0.4803		
1.	25	1874 - 1898	4.7356	-0.4326		
2.	,,	1899 - 1923	4.8283	-0.4215		
3.	,,	1924 - 1948	4.8404	-0.4480	4.8050	-0.4291
4.	,,	1933 - 1957	4.7821	-0.4482		
5.	,,	1908 - 1932	4.8413	-0.3966		
6.	,,	1883 - 1907	4.8022	-0.4274		
1.	30	1874 - 1903	4.7594	-0.4216		
2.	,,	1904 - 1933	4.8474	-0.4158		
3.	,,	1926 - 1957	4.8205	-0.4067	4.8134	-0.4202
4.	,,	1896 - 1925	4.8264	-0.4365		
1.	40	1874 - 1930	4.7820	-0.4329		
2.	,,	1914 - 1953	4.8210	-0.4081		
3.	,,	1918 - 1957	4.8217	-0.4173	4.7993	-0.4229
4.	,,	1878 - 1917	4.7726	-0.4331		

1.	50	1974 - 1923	4.7886	-0.4105		
2.	,,	1908 - 1957	4.8227	-0.3987	4.8057	-0.4046
1.	60	1874 - 1933	4.8081	-0.4061		
2.	,,	1898 - 1957	4.8326	-0.4015	4.8204	-0.4038
1.	70	1874 - 1943	4.8164	-0.4099		
2.	,,	1888 - 1957	4.8335	-0.3930	4.8250	-0.4015
1.	84	1874 - 1957	4.8341	-0.3769	4.8341	-0.3769
55.	Mean of average values of parameter in Cols. 4 & 5				4.8079	-0.4209

Final equation adopted : $Y_T = 4.8079 - 0.4209 \log_{10} \log_{10} T/T-1$

Results and Discussion

It is seen from Table 2 that the values of parameters α and β differ from equation to equation. This indicates that estimates of peak flood for a specific return period based on different set of equations would differ in magnitude. To get a clear picture of this fact, flood magnitudes for return periods of 30, 50 and 100 years are calculated from each of these equations. There are 55 such estimates for each of these floods. These are shown graphically in a series of diagrams in Fig. 3, in each of which abscissa represents the number (n), of years of data in the sub-sample and ordinate gives the value of the flood magnitude for the same return period.

Focussing our attention on any of these diagrams in Fig. 3, say to one that corresponds to the return period of 100 years, it is seen that each of the 16 sub-samples of 10 years has yielded a different value for the same flood of 100 years' return period. Similarly, estimates based on different number of years of data also differ in magnitudes. This is true in cases of flood magnitudes with any other return period.

Thus the estimation of a flood corresponding to any return period depends not only on the length of years of observation but also on the starting year in a particular set of data. But as apparent from the diagrams in Fig. 3, the variability or error in the estimates diminishes with the increasing number of years of data. This fact is also perfectly consistent with the statistical theory.

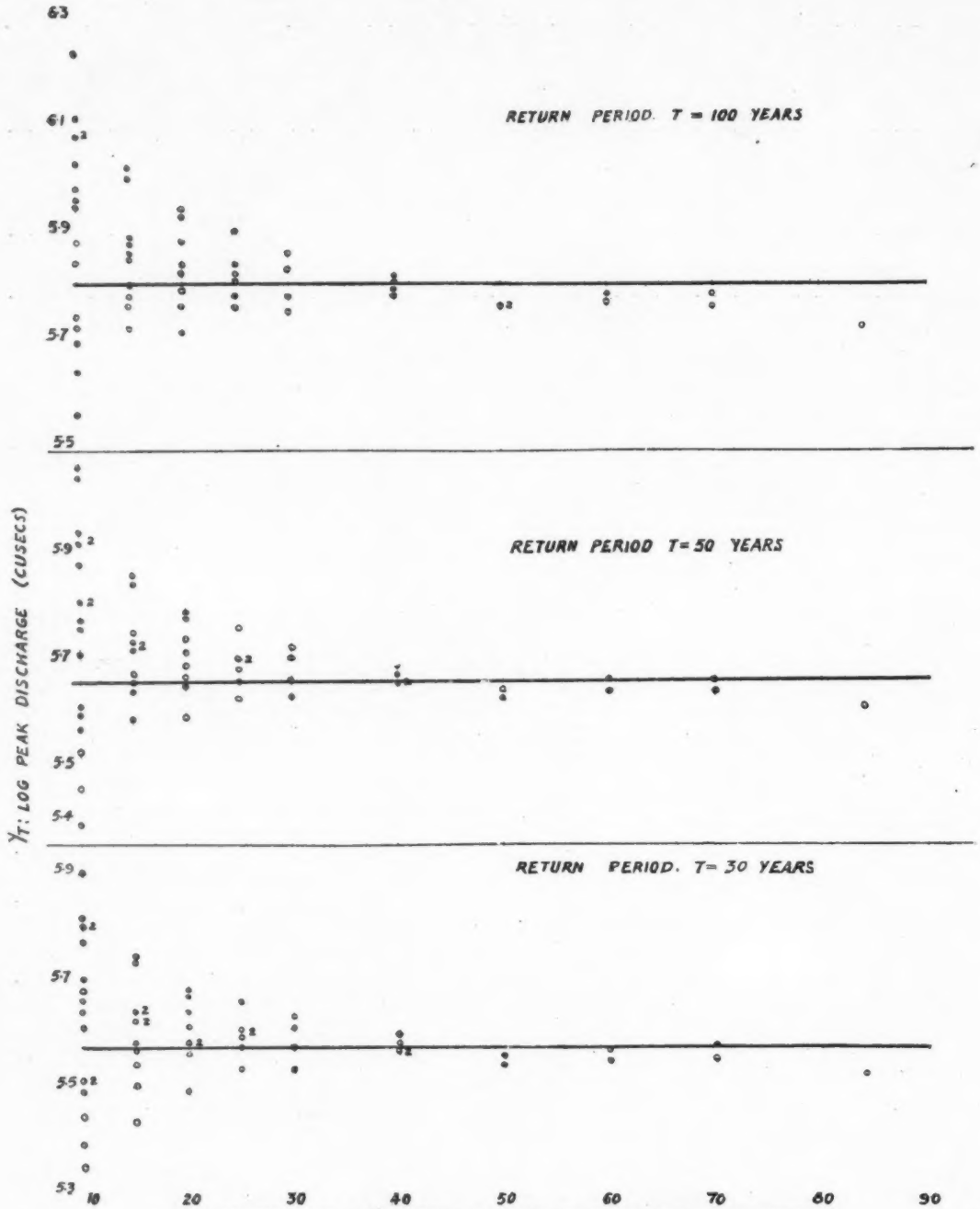
Naturally, the problem now is to seek for the best value for a flood that would be closer to the true one, which in statistical terns meams the hypothetical population value based on infinite numbers of years of data. This is povided by the central value of all the estimates based on the different sub-samples. It can be seen from Fig. 3 that though the estimates based on different sub-samples are different from each other, they fluctuate around a central value. With the increase in sub-sample size the estimates have a tendency to become closer and closer to this central value. In accordance with statistical theory, this central value would be close enough to the real estimate. This leads us to a better approach to the estimation of flood magnitude by averaging over the estimates from the different sub-samples giving equal weightage to the mean of sub-samples of different number of years. This is necessary as the number of sub-samples of different length of record is not the same, and the error in the final estimate would be least. For the purpose, average value for each flood of specific return period has to be worked out from all the sub-samples having same number of years of data separately. Then the mean of all such average values would be adopted as the final estimate. The mean values obtained in this way are represented graphically in the uppermost diagram in Fig. 3. The values for different return period would lie on the same straight line when plotted against the double logarithm of the ratio (T/T-1) of the return periods. The statistical equation corresponding to this equation is easily obtained after averaging the parameters α and β over all groups of sub-samples after weighting them inversely by the number of sub-samples in each group having the number of sub-samples as 16, 10, 8.....etc. Table 2 indicates the necessary calculations involved. The final equation thus obtained is as follows :

$$Y_T = 4.8079 - 0.4209 \log_{10} \log_{10} T/T-1 \quad \ldots\ldots\ldots (3)$$

where Y_T is the logarithm of peak flood magnitudes (in cusecs) and T is the return period in years.

In the light of the above results and discussion, this equation can be considered to be more appropriate for estimating the accurate values for flood magnitudes of different return periods. The estimates of peak floods for different return periods based on this equation (3) are given in Table 3 in lakh cusecs and in the their logarithm.

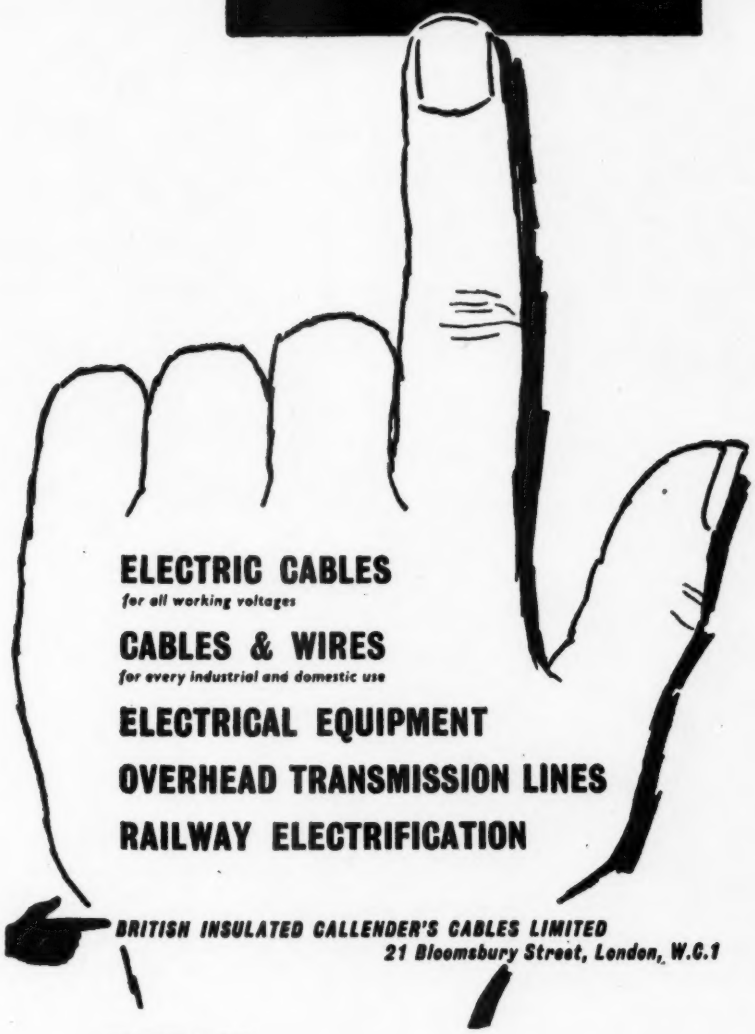
Fig. 3.


RETURN PERIOD T = 100 YEARS
RETURN PERIOD T=50 YEARS
RETURN PERIOD. T=30 YEARS
YT: LOG PEAK DISCHARGE (CUSECS)
SAMPLE SIZE. n (NUMBER OF YEAR IN DIFFERENT SUB-SAMPLES).

ESTIMATES OF FLOOD DISCHARGE IN LOGARITHIMS OF CUSECS FOR RETURN PERIOD OF 30,50 & 100 YEARS BASED ON 55 DIFFERENT SUB-SAMPLES OF DIFFERENT LENGTH OF RECORDS.

[*Continued on page* 49

BICC



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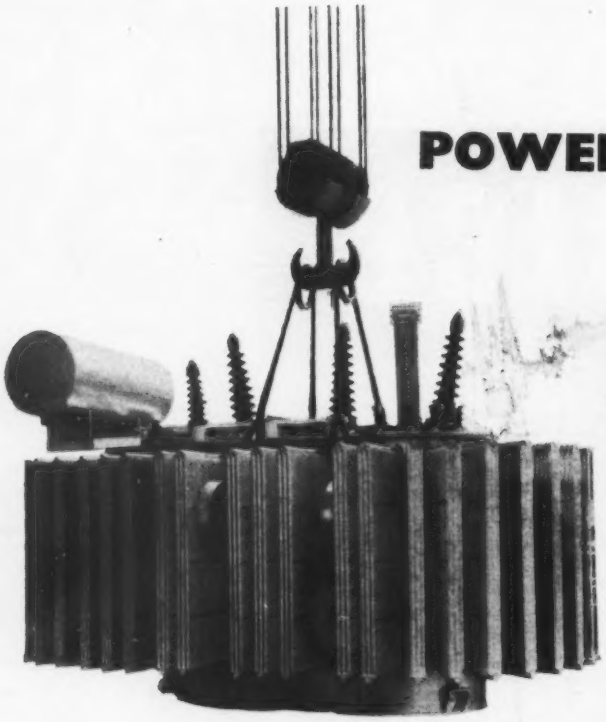

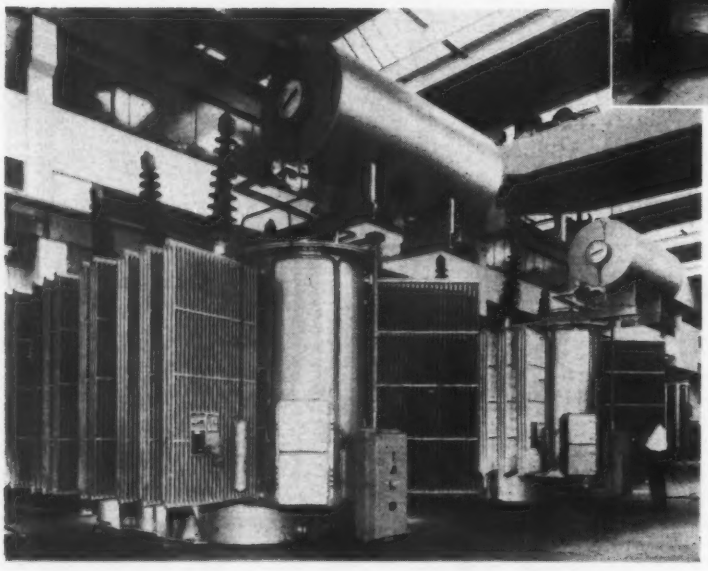

An order from the Chambal Hydel & Irrigation Scheme for nine power transformers, with ratings from 5 to 30 MVA, is now nearing completion. The photographs show some of the transformers that have been delivered.

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A Survey of Present and Future Power Demands of India

By A. SHANKARAN

It is increasingly recognised nowadays that adequacy of electricity supply is an important factor contributing to the advancement of national prosperity through rapid industrialisation. In fact, the history of electricity development has shown that wherever electric power was made available, industrial expansion followed in its wake.

Need for Power Survey

The past fifty years or so have seen the development of electricity supply from a purely local service supplying over a limited radius of distribution, until today when most of the leading countries in the world have comprehensive interconnected or integrated power systems which aim at making the most effective and balanced utilisation of their power resources through co-ordinated operation, thereby producing more and more power at progressively economical cost. The planning of such modern power schemes calls for a proper correlation between power production and power utilisation as, if the rate of growth is overestimated, the capital charges on the excess plant will have to be met earlier than they need have been, and on the other hand if the demands are underestimated there will be plant shortage which will retard the economic development of the areas. The need for such an advance blue-print of power requirements as an aid to planning has been appreciated by our planners, and our Five Year Plans attempt at making power available sufficiently ahead of demand and at the same time ensure a rational programme of power development consistent with economic planning by reducing the interval between the availability of power and its utilisation.

It is in this context that a power load survey of an area over a period of years is essential in order to determine as far as practicable the immediate and potential demands of power under various categories of load. Furthermore, the fact that the distribution of national power resources and the scope for their utilisation rarely exist together within the political boundaries of individual States, necessitates all the more that such a load survey is carried out systematatically on a regional basis and then co-ordinated for the whole country. In pursuance of this objective the Government of India initiated a nation-wide load survey and entrusted the Central Water & Power Commission with this work in April, 1955. In order to have a quick appraisal of the likely power demand and its availability in the country for the next 15 years, the Commission was required to carry out a preliminary load assessment of all the States, basing it on the data readily available with the State authorities concerned and the Central Ministries and to supplement the same by conducting sample surveys in the field. This survey has since been completed and a report is under publication.

For presenting a more comprehensive picture of the power requirements and allied problems of the country, detailed studies requiring intensive investigations in the field are now being conducted, and these are likely to take another three years or so to complete.

Forecasting technique

Electricity development can be made reasonably flexible not only to cater for the immediate needs of a region but also keeping the long term requirements in view. By spending a little more money initially for a system it may be possible to save a larger amount over a period of years by avoiding costly changes at a later date to fit into the ultimate plan. Thus a transmission line may be designed for 220 kV but built for initial operation at 132 kV. If the longterm requirements of a region are properly assessed it would be possible to form an idea of an ultimate plan, and this plan itself could be made flexible enough to be varied, should an occasion arise. This objective of formulating a short-term plan to fit into an ultimate plan naturally raises the question regarding how accurate load foreasting can be. So many natural and man-made factors contributed to the development of load in a particular area that no exact mathematical forecast is possible. The unknown and the uncertain elements involved in the basic assumptions of the load forecast are such that they could completely alter the picture in a few years. However, by an analysis of the statistical data relating to developments in the past in areas of a similar nature, a close study of the prevalent conditions in the area and a scrutiny of the possible factors likely to affect the future adevelopments, it is possible to arrive at an intelligent guess of what the future demand is likely to be. Simultaneous consideration of all the factors is essential. Estimates prepared by different agencies are likely to differ depending on the outlook of the individuals, but if certain general principles are adopted, the percentage difference in the final estimates may not affect the design or the construction schedule of a project.

There is also a mathematical approach recently adopted where the output of electricity tends to conform to an exponential curve or to have a natural redoubling period; for practical purposes, however, this also suffers from the defect that except under steady national and international economic conditions, there may be large and prolonged departures from the general trend, as there cannot be an infinite expansion at an ever increasing rate, which is inherent in the exponential form.

The field survey method wherein the load surveyor visits the various towns and villages of the area to be surveyed and records the present and future needs of

the community is useful for purposes of assessing the immediate power demands of the area. The administrative officers of the Districts and Heads of Government Departments are also contacted for ascertaining local details as also potential demands for their development programmes.

Best results are obtained by a combination of the above methods in determining future power requirements of an area under the various categories of load, giving due weightage to the present trends also. In large and heavy industries such as electro-chemical or electro-metallurgical, a special study has to be made as such loads in a region cannot normally be projected into the future.

Load Growth in India

The use of electrical energy in our country on a commercial basis was commenced in the year 1897. Consumption of electrical energy has increased considerably since that date. However, reliable statistical data regarding the growth of electrical load is available only from 1939. An analysis of load growth in our country can best be made by studying the load growth in three stages, (*a*) load growth prior to commencement of the First Five Year Plan, (*b*) load growth in First and Second Plan periods and (*c*) the likely trend of load growth during the future Plan periods.

(*a*) *Load growth prior to commencement of First Plan.*

The history of power development in India has been both slow and chequered. Electric power supply was mostly in the hands of private undertakings which generally speaking, served the needs of urban population in cities and large towns. No concerted effort was made to develop the electric supply industry or to extend power supply facilities to the rural areas, although there have been a few notable exceptions. Apart from the enactment of the Electricity Act in 1910, designed to regulate the generation, transmission, distribution and sale of power as well as to ensure observance of adequate safety measures, the Government of the day did not take any active interest in electric power development. The period intervening the two World Wars viz. from 1920 to 1940 saw a comparatively significant progress in electricity development mainly due to the awakening of public interest in the domestic and commercial use of electricity. However, during the Second World War and for four to five years after that, the power position remained very unsatisfactory as hardly any significant addition could be made in the installed generating capacity, in fact even adequate repairs and replacements suffered during this period. The installed capacity by 1950 was only 2.3 million kW of which 0.6 million kW was owned by industrial establishments for their own use and the corresponding demand resulting therefrom was 1.6 million kW. Nevertheless the overall load growth in this period followed more or less the trend of doubling in 10 years, in common with other countries.

(*b*) *Load growth in First and Second Plan periods.*

Realising the importance of electricity in the progress of the country, the Government of India have been considering in the past few years the problem of economic generation and utilisation of electric power in the best interest of the country. The passing of Electricity (Supply) Act in 1948, designed to promote coordinated power development in the country, was one of the first measures in this direction. In 1950, Government appointed the National Planning Commission to fomulate a Plan for the most effective and balanced utilisation of the country's resources. The Planning Commission took note of the developments in the progress in various parts of the country and devised measures for their early completion and also authorised among other things a few additional power schemes towards the end of the First Plan. In the light of the experience gained in the First Plan, the Second Five Year Plan was drawn up with a more rational approach. With the implementation of First and with the provisions made in the Second Five Year Plans, our country has been ushered in o an era of industrial revolution. In consequence, the rate of growth of power demand and electricity consumption have shown an unprecedented increase. The installed capacity which was 2.3 million kW at the beginning of the First Plan, increased to 3.4 million kW at the end of the First Plan and the target for the Second Plan is 6.9 million kW. As the benefits of projects included in the First Plan materialised towards the end of the Plan, the increase in the rate of growth of power demand and electricity consumption was also pronounced towards the end of the First Plan. The results of the preliminary load survey on a national basis, conducted by the Commission, (as detailed in Table 1 shown in the succeeding paragraph) indicate that due to the greatly increased tempo in the industrial and economic activities of the country, the rate of electrical load growth, which was corresponding to a doubling period of about 10 years in the First Plan is expected to reach a rate of doubling in nearly 5 years for the Second Plan period. It may be mentioned here that load forecasting in the present circumstances is no longer a simple extrapolation of the past trend. A realistic estimate of the future power requirement can only be drawn after considering in detail the probable load growth of the various categories of loads.

(*c*) *Likely trends of load growth in the future Plan periods.*

In forecasting the total load of any locality it is appropriate to make separate studies of each class of load and then by the adoption of a suitable factor of diversity to arrive at the total load expected from that locality. For purposes of standardisation while undertaking load Survey on a national basis, the Central Water and Power Commission have classified the various loads under the following catgories : (*i*) Domestic and Commercial lighting. (*ii*) Street Lighting. (*iii*) Industries. (*iv*) Irrigation. (*v*) Railway Track electrification, and (*vi*) Water Supply and Drainage.

The relative utilisation of energy in each of the above catgories of load may be gauged from Table 2 for the year 1956. which may be taken as a general guide.

Table 1.

Energy sales by class of utilisation

Class of Utilisation.	*kWh sold Million.*	*Percentage of Total Sales.*
1. Domestic & Commercial lighting and power.	1480.0	18.5
2. Street lighting	117.8	1.5
3. Industrial power.	5323.4	66.9
4. Irrigation.	316.2	4.0
5. Railway Track Electrification	405.0	5.1
6. Water Supply & Drainage.	317.1	4.0

It is likely that this pattern may not change substantially in the next few years, though the consumption of electrical energy by industries will be predominently greater than that of other types of consumers. This is of course to be rightly expected, as power is an essential requisite for industrial expansion.

Table 2 also gives a summary of estimated power requirements of different categories of load during the Second, Third and Fourth Plan periods, based on the preliminary load survey conducted by the C. W. & P. C. for the whole country.

locality based on which forecasts can be made within a reasonable measure of accuracy.

Out of the total number of 5,61,108 localities in our country, 9,304 localities were enjoying the benefits of electrification by the end of 1955. Distribution of these localities and the percentage of electrification under various population groups are indicated in Table No. 3

It is seen that although the balance of localities to be electrified is more than 5 lakhs 90% of such localities have a population of less than 20,000, most of them being villages dispersed throughout the country. During the Second Plan, it is estimated that about 14,100 localities, will be electrified and it is likely that a greater number will be electrified during the Third Plan. Needless to add, a tremendous task awaits our engineers in the programme of Rural Electrification for extending the benefits of electricity to the vast majority of our population.

Street Lighting

The growth of street lighting may also be studied as a function of the growth of population and the demand for power depends on the length of streets and shopping centres as well as on the ability of the local administration to pay for this amenity. For small towns normally 40 watts per lamp may be assumed

Table 2

Category of load.	*Demand at end of* 1955/56.	*Estimated demand by end of :* 1960/61	1965/66	1970/71
	MW	*MW*	*MW*	*MW*
I. Domestic & Commercial lighting & small power.	527	832	1213	1754
II. Street lighting.	37	56	83	118
III. *Industries :*				
(*a*) Small.	254	515	892	1394
(*b*) Medium.	138	352	600	934
(*c*) Large & Heavy.	1285	3037	5544	7717
IV. Irrigation.	127	380	627	943
V. Water Works.	68	128	178	244
VI. Railway Track Electrification.	59	212	524	896
VII. Miscellaneous bulk supplies (for Railways. M. E. S. etc.)	97	136	187	239
Aggregate of simultaneous demands on utilities and non-utilities of all States in the country.	2136	4623	8190	11801

The trend of load growth in each of the categories is briefly discussed below :

Domestic and Commercial Lighting and Power.

The consumption of electricity for domestic purposes directly depends upon the standard of living of the people. What was once a luxury has become a necessity, with the rise of living standards. The greater the population of a locality, the higher is the average living standard and consequently the demand of power. Hence the basic factor is the population of a

whereas for bigger towns 60-100 watts per lamp may be taken. The load factor of street lighting is generally 20-25%. It is also noticed from the recent survey that the demand for street lighting generally bears a relationship to the growth of general and commercial lighting forming about 7% of the latter demand on an all India basis.

Industrial Loads.

In all countries industrial load forms the major portion of the total load, and it is the growth of this

Table 3.

Population Groups.	*Total No. of localities.*	*Localities Electrified*	*Percentage of electrified localities to total*
Below 20,000	5,60,522	8,769	1.58
20,000 to 50,000	401	350	87.45
50,000 to 1,00,000	112	112	100.00
above 1,00,000	73	73	100.00
	5,61,108	9,304	1.56

category that determines the overall load growth of the country. For purposes of estimating loads, industries are classified into small, medium, large and heavy categories depending on the connected load in horse power of the particular industry. However, there is no hard and fast rule regarding classification of industries and one head may overlap the other. Industries having a connected load of less than 25 HP are classified as smll industries, while those having a connected load between 25 and 100 HP are classified as medium industries. Atta chakies, oil ghannies, rice hullers, saw mills, dal mills, ginning factories, refrigeration plant etc. usually constitute small and medium industries. Small industries are to be found practically in all localities, while medium industries are more common in towns. As most of these are for processing agricultural produce for local consumption, the load growth depends on the population and productivity of the localities. When any locality is being electrified, it is assumed that all such small installations that are presently driven by diesel or steam engines will be converted to electric drive within a period of five years after availability of power. In the case of small and medium industries the normal rate of growth is generally about 10% annually for any State or country as a whole.

Industries having connected loads between 100 and 500 HP and above 500 HP are classified as large and heavy industries respectively. Hydrogenated oil mills, large flour mills, small steel re-rolling mills, workshops etc. come under the category of large industries while fertilizer plants, steel palnts, aluminium industries, cement mills, large textile mills etc. constitute the heavy industries. Many of these which are located in places where electricity from public utility is not available, either have their own power station to meet the energy requirements of the industry or use steam engines or oil engine drives. In this analysis, the load growth due to industries having their own power generation is also taken into account. In arriving at the probable demands for electric power and energy requirements for large and heavy industries, factors such as proposed developments and industrial targets fixed for the Second Plan period have been given due consideration. Particularly the programme and targets fixed for basic industries like iron and steel, ferro-manganese, aluminium, rayon, jute, fertilizers, heavy chemicals, paper, sugar, engineering industries, coal mining etc. have been considered individually and their probable demands, have been assessed, and then the total demand arrived at. The establishment of basic industries considerably enlarges the scope for the development of subsidiary industries in the contiguous areas and the power requirements of such industries have also to be taken into account in estimating the loads. A few selected major industries requiring large blocks of power are dealt with in the following paragraphs.

Iron and Steel: being the most important basic industry, it is acknowleged that the industrial development of a country can be judged from the consumption of steel, and this is also very nearly related to the production of electrical energy. If figures for 1955 are any indication, the production of steel in industrially advanced countries such as U.S.A. and Japan, was about 60 and 5 times respectively that of India. Similarly the electric energy produced was nearly 65 and 7 times in U. S. A and Japan respectively as compared to India. In view of the programme for rapid advancement in all the idustrial sectors, the planning Commission has rightly decided on the expansion of steel programme during the Second Plan, which involves an outlay of Rs. 462 crores to increase the production of 1.63 million tons in 1955/56 to 6 million tons in 1960/61. This is to be achieved by expanding the existing capacity of M/s. Tatas from 1 million tons to 2 million tons and M/s. IISCO from 0.57 million tons to 1 million tons in the private sector. In addition three new plants, one each at Bhilai, Rourkela and Durgapur, are being set up in the public sector with an initial production capacity of 1 million tons of steel ingots at each plant. Looking to the present progress made in this direction it is most likely that this target of 6 million tons of steel will be achieved by 1960/61. This capacity will give us 4.5 million tons of finished steel annually and will just about meet our internal requirments and may leave a small surplus for export. The basis for power requirement of this industry is reckoned at 70 to 90 MW for a one million ton plant. It is certain that the capacity of this industry will be increased during the 3rd and 4th Plans to keep pace with the tempo of industrial progress, but definite figures of expansion are yet to be finalised.

Ferromanganese: This is a very important metal required in the manufacture of steel and is processed from manganese are, which is available in plenty in this country. It is reported that world's resources of high grade manganese oré are estimated at 10,000 million tons, of which 65% is available in U. S. S. R. and the associated countries. India has the second largest deposits with 100 million tons of high grade and 200

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million tons of low grade ore. At present the production of ferromanganese is limited and hardly meets the internal requirements. The consumption of this metal is directly related to the production of steel in the ratio of 1:100. It is therefore planned to produce 60,000 tons by the end of the Second Plan to meet the requirements in the country and 100,000 tons for export, considering its capacity to earn foreign exchange. It is proposed to increase the production during the Third and the Fourth Plan periods to keep pace with the steel targets beside the requirements for exports that may reach to 1,25,000 and 1,50,000 by the end of the two Plans respectively. A plant having a production capacity of 30,000 tons is estimated to have a demand of 15 MW.

Aluminium: Amongst the non-ferrous metals, the greatest demand exists for aluminium on account of the various uses it can be put to for domestic as well as industrial purposes. Its demand is rapidly increasing, particularly due its use in A.C.S.R. and aluminium conductors for power transmission. It has almost replaced copper for this purpose, due to its lower cost. India has large deposits of bauxite, nearly 250 million tons, from which aluminium is extracted. The production of this metal in the country was only 7,340 tons at the end of the First Plan. It is proposed to increase the installed capacity to 30,000 tons during the Second Plan by increasing the capacity of the two existing units, namely Indian Aluminium Co. at Alwaye and Aluminium Corporation of India, Asansol, to 5,000 tons each and installation of a new unit at Hirakud, with a smelter of 10,000 tons annual capacity. This capacity was to be further increased by the installation of another unit of 10,000 tons annual capacity either at Rihand in U. P. or at Mettur in Madras State, to achieve the target of 30,000 tons. It now appears doubtful whether the last unit will start production before the close of the Second Plan. The final decision for location of new units for production of aluminium is not yet known, but it is proposed to double the capacity during the Third and the Fourth Plan periods, considering the ever increasing use of this metal by various industries.

For the production of aluminium, electrical energy is considered as raw material in-asmuch as it consumes 22 kWhrs per kg of metal produced. Accordingly it is estimated that a smelter having a capacity of 10,000 tons per annum would require power to the extent of 25,000 kW.

Fertiliser: Although agriculture has been practised in our country from times immemorial, the use of chemical fertilisers has come into practice comparatively recently. The most important of chemical fertilisers are nitrogenous fertilizer and phosphatic fertilizers. The annual consumption of nitrogenous fertilizer in the country at the beginning of the First Plan was 2,75,000 tons. During the First Plan copletion of Sindri Fertilizer Factory, in the public sector and the expansion of the two existing factories, increased the production capacity of nitrogenous fertilizers from 78,670 tons in 1950/51 to 4,89,000 tons in 1955/56. The target for nitrogenous fertilizer for Second Plan taking into consideration the agricultural targets, the increased use of chemical fertilizers, and the anticipated rise in the acreage under irrigation, is 3,82,000 tons in terms of fixed Nitrogen. The increase in capacity, is proposed to be achieved by expansion of Sindri Fertilizer Factory and installation of new units at Nangal, Rourkela, Bhilai, Durgapur, Trombay and Neyvelli. The power requirements, for nitrogenous fertilizer industry has been estimated as 157, 579 and 800 MW at the end of Second, Third and Forth Plan periods respectively. The capacity of super-phosphate industry, which was 123,500 tons per annum in 1950/51, increased to 212, 120 tons by the end of 1955/56. The existing ratio of fixed nitrogen to phospherous in our country is 7:1 as compared to the ratio of 2:1 prevailing in advanced countries. Keeping in view the ratio of nitrogen to phospherous at 3:1 the target of capacity of phosphatic fertilizers by 1960/61 is estimated at 72,00,000 tons. The power demand for the above capacity of super-phosphate, is estimated at 20.8 MW which is expected to increase to 108.5 MW and 183.2 MW by the end of 1965/66 and 1970/71.

Railway Track Electrification

Electrification of railway track is advocated for its advantages like conservation of coal, increased frequency of service, lesser time required for long distance haulage, lesser maintenance expenses, greater revenue etc. The progress of railway track electrification depends on traffic density, both passenger and goods, and other economic factors. The track electrification prgramme for the Second Plan gives priority to those sections which are considered necessary for dealing with the heavy traffic arising from the establishment of steel factories. The assessment of power demands and energy requirements have been made, taking into consideration the route mileage to be electrified and the intensity of traffic on the routes already electrified and to be electrified.

Water Supply and Drainage

In our country, civic responsibility with regard to supply of running water for drinking and sewage pumping is at present confined only to cities and big towns. It is expected that the demand on this account will rise sharply with the rise in living standards. For purposes of estimating the power demand for this category, a consumption of 10 gallons of water per day per person for rural areas, 15 gallons for semi-urban and 20 gallons for urban areas is provided. In big cities like Bombay and Calcutta, the per capita consumption can be as high as 40 gallons per day. Normally, duplicate pumping sets are installed. to provide adequate standby for this essential service.

Assessment of overall power position in the country

The overall results of the preliminary load survey for the country, as abstracted in Table 2 show a demand of 4.62 million kW by the end of the Second Plan period, which is based on the assumption that the present industrial development programme will not be impeded by shortage of financial resources or delay in the availability of power. A target of 6.9 million kW of installed generating capacity including the existing capacity has been provided in the Second Plan. This provision of installed capacity would normally have

sufficed to meet the estimated demand if it were not for the fact tha the surplus in a few power systems may not be transferable to deficit areas for want of or inadequacy of transmission lines. Actually for this reason, and in views of the retarded progress of some of the projects due to foreign exchange difficulties, there will be shortage of power in most of the States aggregating to about 0.40 million kW, the areas chiefly affected in this respect being D. V. C., Madras, West Bengal, Andhra Pradesh and Bomay.

During the Third Plan period, the anticipated demands on utilities and non-utilities will be 8.19 million kW by the end of 1965/66. This estimate of demand is to be considered as tentative till more definite indications regarding the industrial programme for the Third Plan is finalised by the Planning Commission.

On the basis of the ratio of the installed generating capacity to the aggregate maximum demand that existed by the end of 1955/56, the target of 11.5 million kW aimed at by the end of this period would fall short by about 1.5 million kW to meet the overall anticipated demand of 8.19 million kW. The programme of power projects for the Third Plan is also still to be considered by the Planning Commission.

During the Fourth Plan period, the assessed load demand on utilities and non-utilities is likely to rise to 11.8 million kW by 1970/71 as against a provisional target of 22 million kW of installed capacity aimed at. The load forecast of 11.8 million kW appears to be rather conservative as it has been based on the current rate of industrial development, in the absence of any authentic data with regard to new major industrial projects that may come about during the Fourth Plan period. More realistic picture of power requirement will emerge when additional information in regard to major industrial programme, becomes available.

Conclusion

The experience of the last decade has established that wherever power was available at economical rates, the establishment of industries followed in its wake and the power available was consumed much faster than estimated. Such conditions in our country, electrically starved as it is, are expected to continue for another decade or so, resulting in the doubling of demand in five years period. After that, perhaps, the load growth may settle down to a rate corresponding to a doubling period of eight years or so as it occurs in other industrialised countries of the world.

[*Continued from page* 39

Constitution, Functions and Working of the Canals Directorate

are to be prepared in the first instance, of which the manuals on (*i*) Falls and (*ii*) Investigation of Field data required for designing canal structures have been prepared and circulated to the Chief Engineers of States. Manuals on (*i*) Irrigation channels (*ii*) Bridges (*iii*) Cross Drainage Works, (*iv*) Regulators, (*v*) Barrages, (*vi*) Falling Shutters, (*vii*) Irrigation Water requirements and *viii*) Irrrigation Water Measurements & outlets are in the progress of preparation.

Museum—An Engineering Museum of models of the various River Valley Projects is being maintained by the Central Water and Power Commission. The Commission has been participating in the Exhibitions sponsored by public and private bodies from time to time. to time. The Commission organised the Irrigation Power Pavilion in the "India 1958" Exhibition in which models of Irrigation and Power Projects from the Museum and other States were exhibited.

Rates and Contracts Division

This Division has since been transferred to Cost Accounts Unit.

175 project estimates were received from various states and were scrutinized and comments issued in respect of rates and provisions. These projects involve huge quantities of earthwork where earth moving machinery is to be used. Tender documents and schedule of rates were also scrutinized and finalised. Studies were also made on the preparation of estimates and cost trends. Suggestions for reducing cost of large projects, rehabilitating displaced population, policy to be adopted in sanctioning irrigation projects and methods for working out the percentage return on irrigation projects were made.

Some of the major project estimates scrutinized are of Kosi, Hirakud, Kakrapar, Rihand, Nagarjunasagar, D. V. C., Chambal and Bhakra Nangal Projects.

Prestressed Concrete Division

This Division has been created for the purpose of compilation of the information pertaining to prestressing steel process and costs of the prestressed concrete structures constructed so far or under construction in the country. In all, about 55 structures have so far been constructed, the number of bridges being nearly 50. Some works continue to be in progress. All such information is being presented in a report form to the next Seminar of Irrigation and Power Egineers for drawing up recommendations in respect of use of high tensile steel for prestressing concrete structures, in order to economise in the use of steel. Data has so far been collected from the States of Madras, Kerala and Punjab for 10 structures. The data from other states will also be collected in due course. The prestressing of concrete structures effects a considerable saving in the use of cement concrete and steel. It is consequently of great advantage in building long spans. For the same span and loading prestressed concrete structures require about 50 per cent less of cement concrete and about 60 per cent less of steel. High tensile steel used in prestressing is imported from abroad and is costlier than ordinary mild steel, yet its use in prestressed concrete structure reduces the cost of steel by about 20% in comparison to the cost of mild steel to be used in reinforced structures.

There are various patent systems of prestressing in different countries of the world, but the following prestressing systems appear to have been used in this country: (*i*) Freyssinet (*ii*) Magnel Blaton (*iii*) Gifford-Udall-C C L (*iv*) Lee-Mcall (*v*) Italiam 'R' and Mandi systems. (*vi*) Holzman and (*vii*) Leoba.

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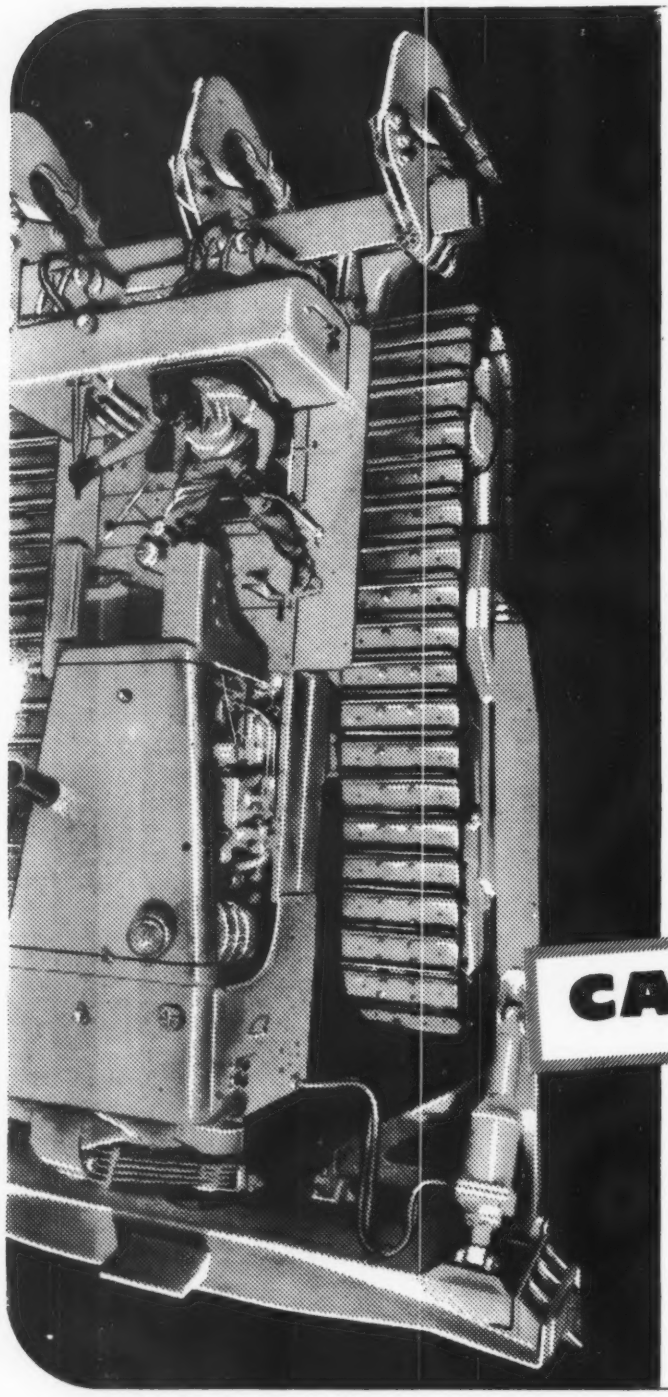

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Our Schools for Training in Earth-Moving Machinery

By J. E. VAZ

A visit to India—1958 Exhibition would have convinced anyone of the all-out efforts which New India is making to keep pace with the advanced countries of the world. The country already has a net-work of gigantic development projects—the temples of modern India as the Prime Minister called them —which have been provided for in the successive Five Year Plans. Soon after these Projects were launched, it was realised that the targets fixed could be realised only with modern mechanised construction and earth moving equipment. For the efficient operation and maintenance of such costly construction earth moving machinery, used in the execution of these projects, it was necessary to provide well qualified operators, mechanics, and supervisory staff properly trained on scientific lines in order to make the best use of it. Consequently the Government of India embarked upon a scheme, the first of its kind in this country, for imparting the required training to suitable technicians already possessing general technical skill.

Two Technical Training Centres were accordingly set up by the Government of India in collaboration with the United States Technical Co-operation Mission in India. The first training Centre was opened on the first of November, 1955, at Kotah (Rajasthan) and the second Centre started functioning at Nagarjunasagar (Andhra Pradesh) on the 27th of June, 1956. In choosing the site for the Centres the consideration in view was to locate them near suitable projects, where there was ample opportunity for giving adequate practical training to the students.

Each of these two Centres has a provision for training 40 persons at a time, at a one year's intensive course. Recruitment is made both from the open market and from amongst the nominees of various projects. In order to be eligible for admission to the Schools, a candidate should be at least a matriculate, must have a good physique, and in addition to having a driving licence for light or heavy transport vehicles, should possess at least one year's practical experience in heavy earth moving equipment. These basic educational and physical standards, coupled with practical experience, have been prescribed with a view to ensuring that the trainee can assimilate properly the theoretical as well as the practical training. Further, in order to attract the proper type of men, the Govt. of India pays to each trainee a stipend of Rs. 100/- p. m. in addition to providing him with rent free accommodation with free water and electricity. To obtain the best possible candidates, applications in

A Group of trainees overhauling a crawler tractor.

Trainees practise on road-making with motor grader

case of direct recruits are invited for each session from all over India through advertisement in all leading newspapers. A preliminary selection is made and those selected are interviewed by a Board of Engineers at various centres.

Run by the Central Water and Power Commission, each Training Centre is in the overall charge of a Deputy Director, who is assisted by necessary teaching staff. The United States Technical Co-operation Mission in India have also assigned American Experts to give specialised training at both the Centres. Equipped with various types of modern earth moving machinery, each Centre has among other equipment a bulldozer, a motorised scraper, a drawn scraper, a motor grader, three rear dumpers, a mobile workshop unit, a mobile servicing unit and an excavator.

In order to achieve the best results the 40 trainees, at each session are divided into three groups. During the first 6 months each group spends two months on overhaul and maintenance of internal combustion engines, fuel pumps etc. at the workshop, and four months on operation and daily maintenance of the equipment of the Centre. Practical training is accompanied by regular technical lectures by the T. C. M. specialists and other supervisory staff.

During the second period of six months, the trainees have to work on actual production jobs of various types. During this period, arrangements are also made for lectures by specialists representing various well-known firms dealing in earth-moving equipment. The training is augmented throughout the year with the help of audio-visual aids for which a 16 m. m. projector, complete with necessary equipment, has been provided, at each Centre.

Written and practical tests are held each quarter. The final examination is conducted by a Board of Examiners appointed by the Central Water and Power Commission. Those who qualify are granted a Proficiency Certificate, which indicates the machines on which the candidate has been tained and the grading achieved both as mechanic and operator. Those who obtain 80% and above marks are placed in Grade I, those getting 66-80% in Grade II and the rest in Gd. III. Those obtaining less than 50% marks do not qualify for the Certificate. Immediately after they successfully complete their training, the particulars of trained operators and mechanic are circulated to Projects with a view to having them fixed up in suitable jobs. If no job is offered to a trained candidate within three months of his passing out from the Centre, he is allowed to take up private employment.

The non-recurring expenditure incurred on setting up these two Centres was about Rupees 26 lakhs. The recurring expenditure is Rs 2 lakhs per annum for each Centre. It is hoped that this expenditure would provide a profitable investment for the country and bring adequate return in the form of better operation and maintenance techniques.

These centres were initially sanctioned for a period of five years. In view, however, of the present day needs of the country and the keenness shown by its youth to receive this training, as is evidenced from the large number of applications received for training at each Session, it might well be hoped that this scheme will be continued for some years to come—with the help of the United States Technical Co-operation Mission in India, but for whose aid it would have been difficult to establish these Centres.

Constitution, Functions and Working of the Canals Directorate

By S. RAGHAVACHARI

This Directorate has been in existence in the CW & PC from the year 1950 and an account of its working in the previous years has been given in Special Number of November, 1954 of the India Journal of Power & River Valley Development. As at present constituted, it consists of a Director with 4 Deputy Directors, each in charge of a Division.

Till 1958, the Rates & Contracts Division was attached to this Directorate, and with the formation of Cost Accounts Directorate, this Division has been passed on to that Directorate. The functions of the Divisions are as below :—

Headworks Division

This Division prepares Project specification and construction designs including remodelling of existing structures for canal diversion works consisting of weirs, barrages and low dams upto a height of 50′, canal headregulators, silt control works, fish ways, locks and training works and afflux bunds. It also scrutinises designs and advises on river diversion works sent by the States for check.

Canal Structures Division

This Division scrutinises the data and undertakes designs of canals and all structures on the canals viz. cross regulators, falls, cross drainage works, bridges and escapes, head sluices for branch canals. It also deals with the alignment plans, canal sections, longitudinal sections and scrutinizes design of structures received from the various projects.

Drawing and Estimating Division

This Division is engaged on the preparation of quantity estimates and material lists for all structures designed in the Canal Structures Division, scrutiny of I. S. I. specifi cations and the procurement and issue of all stores and instruments, stationery, technical and scientific, maps etc., besides the charge of blue and ozalid printing machines and all printing work of drawings for the entire Commission. The maintenance of the Engineering Museum and participation in Exhibitions also devolve on this Division. The draft Manuals on design of the canal structures are also being prepared in this Division.

Rates and Contracts Division

This division keeps an uptodate record of schedules of rates in all the States and major river valley projects in progress in the country, scrutinises the estimates of investigated projects and tenders and contracts in respect of projects which are referred to CW & PC by the Government and studies price trends, with particular reference to its effect on the cost of projects and prepares cost curves for use of investigating engineers.

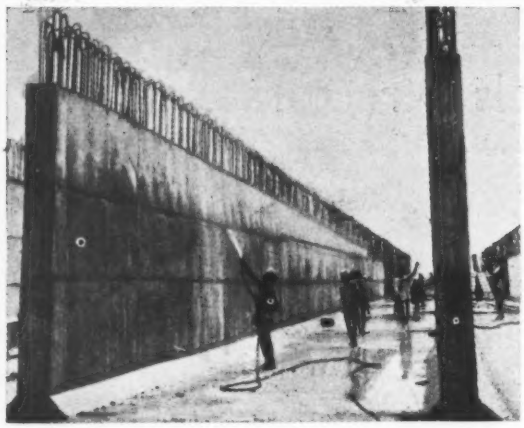
The more important works done by each Division are shown below :—

Headworks Division—Designs, estimates and specifications have been prepared for a number of weirs and barrages. The most important works designed are barrages and weirs on the Kosi, Mahanadi etc. In all these cases, preliminary designs were prepared and tested by model experiments at CWPRS, Poona, for suitability of location, alignment, silt control, dissipating arrangements, afflux etc. and the final designs took into account the results of model experiments.

The salient features of important works dealt with in this division are as under :—

Wazirabad Barrage—The problem has been that the deep channel of the Yamuna river has been shifting towards the left from the intake towers of Wazirabad pumping station which supplies water to Delhi during falling floods and low floods. Consequently, every year a channel had to be cut in the bed of the river to bring water from left side course to the intake wells involving cost and interruption in supply if not done in time. In order to obviate these difficulties and ensure firm water supply, a weir was proposed but with reference to further experience this year it was changed to a barrage with a battery of undersluices on the intake well side for which designs and estimates were prepared. The work has been taken in hand. The average bed level of the river is 664.0 feet and the crest level of spillway and undersluices is 665 and 661 feet respectively. The gates are 10′ high. The barrage will also carry a roadway of 24′ with 2 sidewalks relieving to a great extent the congestion at the existing bridge.

Kosi Barrage—This barrage under construction is located near Hanumannagar village, about 30 miles from Chattra in Bihar, across the Kosi river. The main problem of the Kosi river has been its lateral movement. The river has excessive slope and consequent excessive bed load and coarse silt charge in the higher reaches. On reaching the plains, the country slope becomes too flat to maintain velocities necessary for coarse silt transportation. This results in deposition of coarse charge and splitting up of Kosi into a large number of inter-lacing channels below Hanumannagar. With the construction of the barrage, which contemplates, raising flood level by about 12′, the excessive river gradient upstream of barrage would be flattened and erosion on sides and silt charge would be considerably reduced. The river will also be tied down



Kalisindh Acqueduct : showing R. C. C. Trough under construction

to the present course by the barrage and the embankments above and below.

The barrage is designed to pass a flood discharge of 9,50,000 cusecs and consists of 56 bays of 60′ each, of which 10 bays, 6 on the left and 4 on the right serve as undersluices. It combines with it two fish ladders one on each side adjacent to the undersluices. The barrage will be subject to a maximum head of 29.5′ and barrage floor will be R. C. raft.

The barrage will also provide irrigation to an area of about 1.5 million acres for which purpose two canals take off, one on each flank of the river with a full discharge of 15,000 cusecs and 2,500 cusecs respectively. Silt excluders are provided at the head-regulators on either side to exclude coarse silt from entering the canals.

A two lane road bridge and a meter gauge railway bridge are also combined with the barrage to provide means of communication across the river.

The barrage is estimated to cost about Rs. 45 crores. The work on East Canal head regulator and undersluices has been taken up for execution and the designs for these have been prepared and furnished. Designs for the remaining portion are in progress.

Mundali weir—This weir is proposed to be built across the Mahanadi river about 200 miles downstream of the Hirakud Dam and about 12 miles upstream of the existing Mahanadi weir at Jobra. It would enable water released from Hirakud dam after power generation being utilised for irrigating about 5.3 lakh acres of land in Puri and Cuttack districts in Orissa. A canal takes off from the right flank with a maximum discharge of 6,000 cusecs.

The weir is designed for a maximum flood discharge of 12.0 lakhs cusec. The weir consists of 4 bays of pocket sluices each 60′ wide, 6 bays of river sluices 60′ wide, and a weir length of 3689′ with 3 ft. falling shutter and measures 4353′ from face to face of abutments. Two sets of navigation locks are provided for navigation facilities in the river as well as in the Puri Right Main Canal. Drawings and specifications have been furnished for this work and tenders are being called for execution.

Rourkela Weir—This pick up weir across the Brahmani river about 3 miles of the Rourkela Steel Plant, is designed to supply water required for Rourkela Steel Plant.

The final design provides for a weir with automatic falling shutters of 3.5 ft. height. The overall length is 1284 ft. and will cost Rs. 60 lakhs.

Drawings, designs, specifications and estimates for the project have been supplied to the Rourkela Steel Plant authorities and construction of the weir is in progress.

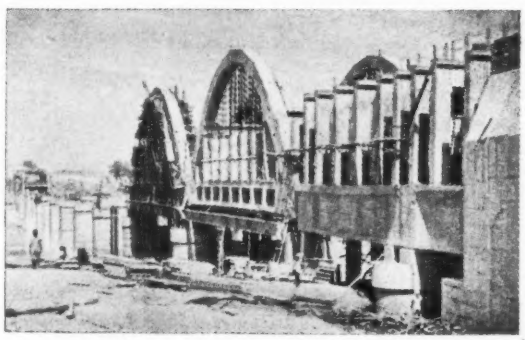
Canal Structures Division

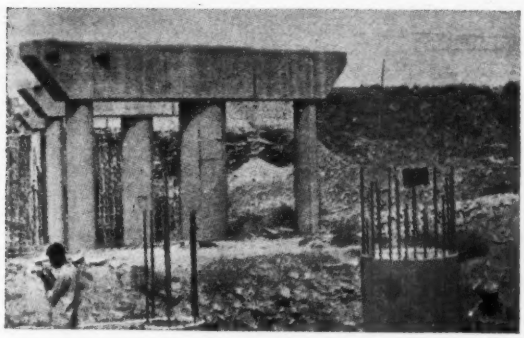
During the last 4 years about two hundred canal structures have been designed for various river valley projects and scrutiny also has been carried out of all the designs of important canal structures incorporated in the project reports, specially referred to us. The most important ones are described below:—

Chambal Project—Kalisindh Aqueduct—The Chambal Right Main Canal with a discharge of 5400 cusecs crosses the Kalisindh river in Rajasthan by means of this aqueduct. During the high flood conditions the river carries discharge of 5,28,000 cusecs, with a maximum depth of 28.85 at the deepest bed. The aqueduct consists of five 13.5′ wide R. C. C. compartments with the partitions acting as beams and spanning the river by means of 27 spans of 40′ clear each. The partitions are stiffened by means of transverse R. C. C. struts @6′ c/c. One of the end compartments is covered to provide a 12′ wide roadway. The substructure is coursed rubble masonry in lime surkhi mortar and rests on sandstone rock foundation.

Parwan Aqueduct : The Chambal Right Main Canal with a discharge of 5370 cusecs crosses the Parwan river in Rajasthan by means of this aqueduct. During high flood conditions

Parvati Acqueduct: Land spans & Bowstring Arch completed for first 2 longer spares along with substructure for the remaining spans





Kunu Siphon : Piers in progress with capping beams for some piers

the river carries a discharge of 4,15,000 cusecs with a max. depth of 39.19′. The structure consists of a trough 56′ wide with masonry side walls. The main superstructure consists of 22 spans of 40′ masonry arches. A 12′ wide roadway also supported on arches is provided outside the trough at a lower level. The substructure is of coarse rubble masonry in lime surkhi mortar resting on rock.

Parvati aqueduct—The Chambal Right Main Canal with a discharge of 3900 cusecs crosses the Parvati river by means of this aqueduct before entering the Madhya Pradesh territory. During high floods the river carries a discharge of 5,60,000 cusecs with a max: depth of 79′ at the deepest bed. The departmental design consisted of 21 spans of 60′ closed box type barrels supported on concrete substructure. The revised design submitted by M/S. Joshi and Verma, Contractors, was finally adopted. This consists of 12 bowstring girders of 107′3″ with 5 shore spans, 3 of 50′ and 2 of 24′ of R. C. beams. This supports are R. C. trough 32′ wide with a roadway over it 24′ wide. The substructure consists of R. C. hollow column over R. C. well foundations.

Kunu syphon—Chambal Right Main Canal with a discharge of 3156 cusecs crosses the Kunu river by means of this syphon. During maximum flood conditions the river passes a discharge of 2.8 lakhs with a depth of 63.2′ at the deepest bed. The valley is 6000′ wide and after examining many alternatives a canal syphon was finally adopted. Original design consisted of an R. C. pipe 20′ diameter and 6000′ long laid over the ground and crossing the river proper by means of 11 bowstring girders of 60.5′ span with two 12′ roadway bridges of R. C. decking on either side. The substructure consisted of masonry piers with spread foundations.

A revised design submitted by M/s. Gammon(India) Ltd., contractors and prepared by S. T. U. P. France, is finally adopted after scrutiny. In this design the R. C. pipe is replaced by a prestressed concrete pipe of the same diameter with the pipe itself acting as a beam in spanning the river portion with 11 spans of 85′. Two prestressed concrete roadway deckings are provided in the river portion, one on either side of pipe line. The substructure consists of R. C. C. columns resting over mass concrete footings taken minimum 25′ below the river bed.

Hallia Aqueduct Nagarjunasagar Project: The design was for an aqueduct for a canal discharge of 15,000 cusecs carried over masonry through arches. Two 12′ wide roadways run on the outside of the canal at a lower level. The aqueduct crosses the river in 24 spans of 30′ each to pass a flood discharge of 2 lakh cusecs. After examining a number of alternatives, the arch type has been adopted, as this involves minimum use of steel and conserves foreign exchange.

Drawing and Estimating Division

Technical Scrutiny. Technical scrutiny of the designs of structures included in the project reports has been carried out for about 145 projects. Designs of waste weirs, head sluices of canals, weirs and barrages, head regulators of canals, alignment, capacity and design statements and structures on canals and branches were technically examined.

In addition schedule of quantities and estimates were prepared from drawings and designs and supplied to the project authorities. Miscellaneous works such as the preparation of charts, maps and drawings for the 1958 Exhibition were prepared.

The more important works scrutinized are Harike Project Punjab, Chambal Valley Development in M. P. and Rajasthan; Tungbhadra Project in Andhra; Extension of irrigation in Mahanadi Delta in Orissa; Vir Dam and New Khadakwasla Dam projects in Bombay; Ukai Dam Project in Bombay, Rapti Canal Project in U. P., Neyyar Irrigation Project in Kerala; Sadasagar Reservioir Project in U. P.; Kangsabati Reservoir Project in West Bengal, Augmentation of Delhi Water Supply and Sone Project in Bihar.

Estimates—Besides a large number of estimates of quantities comprising of details of measurements, abstract of quantities and material statement of different canal structure such as aqueducts, drainage syphons canal syphons, regulators, falls and bridges were prepared during the period.

Manuals—In order to have uniform procedures for designing irrigation works, the work of preparation of manuals has been taken up. About 20 manuals

Parwan Acqueduct : Showing Arches under construction . (15 Arches completed upto 1-6-59)

[*Continued on page* 34

Central Water and Power Research Station

By S. L. BANERJEE

The Physics Division of the Central Water and Power Research Station deals with certain applied branches of geophysics useful in civil engineering, particularly those connected with the different River Valley Projects.

In the initial survey phase, by one or more of the four well known geophysical methods, viz., Seismic Refraction Electrical Resistivity Magnetic Survey and Gravity Survey, a very clear idea of the depth to bed rock at any selected site is obtained. Seismic refraction method utilises the difference in wave velocities in soil and rocks for the estimation of the depth to bed rock. The Electrical Resistivity method depends on the contrast of electrical resistance of different strata. Generally these two methods are adequate in estimating the foundation rock depths, which is our main interest. However, a magnetometer survey is very useful in locating any subsurface dykes, sills, a fault involving displacements of magnetic formations or contact between rocks of different magnetic properties brought about by Plutonic intrusion or by volcanic lava or by normal sedimentation over an igneous basement.

Here, mention may be made about the very low cost of the geophysical survey as compared to drilling cost. The drilling costs about Rs. 20/- per foot of core drilling in soft rock whereas on the average a seismic or electrical determination of rock depth upto nearly 100 ft. costs about only Rs. 40/- per point. So far more than 30 dam sites have been investigated, and results for bed rock depths have been supplied which give the designers an overall idea of substrata and hence better estimation of costs for the project. A few surveys have been made for the study of ground water also and here a fair idea of the extent of the water-bearing strata can be obtained.

Certain engineering properties of soil in-situ are being determined by an analysis of wave propagation through it. A mechanical vibrator is used to generate vibrations in soil and by the study of waves of different period some of the quantities like Young's modulus, Poisson's ratio etc. of the soil are found out. The equipment is very bulky and heavy, and the final aim is to form a code for machine foundations.

For the actual design of foundation, information about the Young's modulus, rigidity and Poisson's ratio of foundation rock cores are necessary and these are determined by some of the dynamic non-destructive methods—viz. sonic (resonance) method, mechanical pulse method and ultrasonic testing methods. All three types of testing are very rapid and leave the specimen intact also for any other tests. The results agree very well with those obtained by static methods. By some of these methods the elastic constants of cement concrete can also be found. However, some work in the direction of finding these values in-situ is being envisaged.

The completed structures, like dams, vibrate when water is allowed to fall at foundation, or allowed to gush through gates or spill across spillway or siphoned out by either volute siphons or siphon spillways. For all small forces of vibration, the structure vibrates in one of more of its many modes of vibration possible. A study on these leads one to an accurate determination of some of the elastic constants of the material in-situ. More violent vibrations as are produced while working volute siphons can be assessed in terms of a fraction of g, the gravitational force.

It is also possible to analyse the probable cause and mechanism of operation of these disturbing forces. Some dams in India have been tested by such vibration studies.

Some special problems arise in the Himalayan region, which is a very active seismic zone. Hazards of earthquakes, landslides etc. have to be taken into consideration while selecting the site itself. A study of the entire region is being made from the past records of earthquakes. A very well-equipped Seismological Station situated at Chatra in Nepal regularly supplies data for analysis by this Division for its engineering use. A general study of very minor local earthquakes having epicentres upto a distance of 450 kms from the observatory has been made from the year 1951 till to-date. Some important conclusions have been arrived at regarding the frequency of occurrence of local shocks with regard to rate of change of surface loading by rainfall, as seen from the flood discharge of Kosi river.

In addition, a study of microseisms due to storms as recorded in seismographs all over India has also been made. This study helps in a general way to explore the overall geological blocks in and around India and also to study certain seismological and oceanographic characteristics at sea.

Further, an attempt is being made to study the behaviour of elastic waves across planes of discontinuities, such as faults, and their dispersion with the help of model seismic methods.

A number of instruments are being received from United Kingdom under the Colombo Plan and it is felt that the field of activity of the Physics Division will increase much, and it may be able to serve the cause of engineering research more and more in the future.

Technical Scrutiny of Irrigation Projects

By K. B. KHUSHALANI

When the national Government took over in 1947, it faced two important problems. One was the serious food shortage and the other was the necessity to improve the economic condition in the country. To solve these problems the Government rightly decided to put abundant water resources into effective use by undertaking river valley projects, which were to help in increasing agricultural production and generating cheap power for use of medium and large scale industries to be established. Projects were, therefore, immediately launched which were later on included in the first Five Year Plan. Due to lack of sufficient time and people's desire to cope up with the food situation these schemes were prepared with whatever data that was available at the time. Naturally in the course of execution, it was found that in several cases design had to be changed and estimates recast and some of them were not the best for the particular region. This resulted in enormous increase in cost of several projects and the benefits contemplated were also not realisable to the extent envisaged. To avoid this state of affairs and to ensure that the projects taken up for execution in the second Five-Year Plan were complete in investigations, technically sound, economical & estimates were adequate and realistic, in October 1953, Planning Commission set up a Technical Advisory Committee on Irrigation and Power Projects to make a thorough examination of the projects and to recommend suitable projects for sanction.

Simultaneously the Directorate of Technical Examination was set up in the Central Water and Power Commission to scrutinise the irrigation and multipurpose projects costing Rs. 10 lakhs and above. It was stipulated that no medium and major river valley project of the second plan costing Rs. 10 lakhs and above could be taken up for execution before it was scrutinised by the Central Water and Power Commission and approved by the Technical Advisory Committee.

The importance and necessity of detailed examination regarding the technical and economic soundness of a project can be realised when the total outlay on irrigation and power sector is considered. In the first Plan, irrigation and power outlay was Rs. 570 crores and the second Plan provides an outlay of nearly Rs. 900 crores. These figures represent huge amount of public money and naturally undertakings of this kind require thorough scrutiny.

Technical Advisory Committee

The Technical Advisory Committee consists of the representatives of the Ministry of Irrigation and Power, Ministry of Finance, Central Water and Power Commission, Planning Commission and two non-official Members. The Adviser (Irrigation and Power) Planning Commission is the Member Secretary. Directors in charge of Technical Examination in the Water and Power Wings of the Central Water and Power Commission are the Additional Secretaries. The Deputy Minister, Irrigation and Power Ministry is the Chairman of the Committee.

The functions of the Committee are to examine irrigation and power projects proposed by the State and Central Govts. and other authorities and to satisfy themselves about the proper preparation of projects, viz, sufficiency of investigations, technical soundness, correctness of financial forecasts and estimates, and on the basis of such enquiries, to advise the Planning Commission on the merits of the individual projects. Its functions do not include laying down of priorities as between the projects. It may usefully assess and indicate, the relative merits.

The meetings of the Committee are held on an average once in two months.

Principles for Inclusion of Projects in Plan

Generally the following criteria have been applied for selection of projects for the second Plan.

(*a*) Thoroughly investigated projects.

(*b*) Projects which are more remunerative in direct financial returns and those which yield quick results.

(*c*) Projects which will add to agricultural production.

(*d*) Selection of projects on the basis of availability of annual pecipitation i. e. whether the projects are located in zones, of scarcity areas or zones of ample rainfall.

(*e*) Regional development with a view to reduce disparities in economic opportunities between the States.

Steps taken in Scrutiny and Sanction of Projects

All projects costing more than Rs. 10 lakhs are technically scrutinised by the Central Water and Power Commission before putting them up to the Technical Advisory Committee for sanction. The projects are grouped into two cost categories; (1) projects costing above Rs. 1 crore, and (2) projects costing below Rs. 1 crore.

Both categories are scrutinised in the Technical

Examination Directorate. In the case of projects costing more than Rs. 1 crore the projects are also circulated among other specialised Directorates concerned such as Hydrology, Waterways, Irrigation and Navigation, Dam Designs, Canal Designs and Cost Cell for examination of the aspects concerning them. The comments received from the various Directorates are then studied in the Technical Examination Directorate and processed. The projects costing below Rs. 1 crore are examined entirely in the Technical Examination Directorate. As far as the flood protection schemes are concerned all schemes above Rs. 10 lakhs are examined in the Flood Wing of the C.W. and P.C. The financial scrutiny, in addition, is also done by the Finance Officer of the Union Ministry of Irrigation and Power for all projects falling under both the categories. The following aspects of the project ar examined in detail :

(*i*) Planning and adequacy of investigations.

(*ii*) Riparian rights and in respect of inter-state projects, concurrence and participation of the concerned States.

(*iii*) Hydrology:
Rainfall, dependable yield, optimum utilisation of water resources, maximum flood discharge, silt reserve, live storage, evaporation and absorption losses.

(*iv*) Irrigation:
Availability of commanded area and its suitability for irrigation. Intensity of irrigation, duty, crop pattern, working tables for the reservoir, subsoil water level, overlapping of irrigated areas, soil survey and water rates.

(*v*) Navigation.

(*vi*) Power:
Available potential, market for power.

(*vii*) Other benefits like flood control etc.

(*viii*) Design:
Type of design most suitable for each site, spillway design, spillway channel, gates, head regulators, alignment of canal and its design and design of masonry structures on canal.

(*ix*) Estimates:
Analysis of rates for various items including rates for works to be done by machinery. Whether provision under various sub-heads is adequate and all heads are covered, and allocation for cost in case of inter-state or multipurpose projects is properly made.

(*x*) Financial Returns:
Checking of financial returns including irrigation rates and betterment levy.

After the detailed examination of all aspects of the project is complete the final comments are passed on to the Technical Advisory Committee with recommendations of the C. W. & P. C. giving briefly the points requiring attention. On the acceptance of the project by the Advisory Committee, the Planning Commission takes further action for giving the sanction to the project subject to compliance of the comments.

Plan Projects Scrutinised

First Five-Year Plan:

At the time of the formation of the Technical Advisory Committee, there was no programme for scrutinising the first Plan schemes. But in the later stages of the first Plan some of the first Plan schemes were also received for technical scrutiny in the Central Water and Power Commission. The total number of irrigation and multipurpose schemes under first Plan was 293 costing Rs. 860 crores. Out of these the C. W. & P. C. examined 51 schemes costing Rs. 441 crores.

Second Five Year Plan

When the second Plan was being formulated it was assessed that number of schemes proposed to be included in the second Plan were not investigated fully and even lacked details essential for technical and financial scrutiny. At the end of 1954, it was brought out in the Second Meeting of the Advisory Committee that only 44 irrigation projects had been investigated out of 160 while project reports received were only for 15. A large number of such projects had, therefore, to be included in the second Five-Year Plan pending such investigation and revision as might be necessary. At present the number of irrigation projects included in the second Five-Year Plan up to December, 1958 are 215 with estimated cost of Rs. 480.633 crores and will irrigate an area of 168.231 lakh acres. These projects grouped according to their size are as under:—

	No	*Benefits in (lakh acres)*	*Estimated cost (Rs. lakhs)*	*Expenditure tentatively approved by the Planning Commission during 2nd Plan (Rs. lakhs.)*
Below Rs. 1 crore.	153	12.722	5,231.88	4,564.18
Between Rs. 1 to 5 crores	42	27.702	9,602.75	4,869.05
Above Rs. 5 crores	20	127.807	33,228.64	6,223.30
	215	168.231	48,063.27	15,656.53

Out of the above 215 schemes, reports for 132 have been received till December, 1958 in the Central Water and Power Commission. The stage of examination and approval of the Planning Commission is as given below:—

	Number	*Cost (Rs. lakhs)*
1. Schemes for which C.W.& P. C. examination is complete & final comments sent to Advisory Committee	81	19,756.21
2. Schemes under examination by C.W. & P. C. for drawing preliminary comments	8	5,781.26
3. Schemes under examination by C. W. & P. C. for drawing final comments.	7	6,473.51
4. Schemes for which preliminary comments have been sent & clarifications are awaited from the States.	36	3,955.34
	132	35,966.32
		Say Rs. 360 crores.

From the above statistical information it is evident that for projects totalling Rs. 200 crores, technical examination by C. W. & P. C. is complete while projects amounting to a total of Rs. 160 crores are either under examination and clarification or awaited from the State Chief Engineers. 83 project reports totalling Rs. 120 crores are still awaited from State Governments and other authorities.

Percentage of Economy Effected

The upper most aim of the scrutiny of the projects had always been that the projects are technically sound and that the provision made in respect of rates and costs of construction, water rates, betterment levy etc. are correct and adequate. From Table I. it will be seen there in that a saving of nearly Rs. 15 crores has been made in projects totalling to Rs. 290 crores.

Third Five Year Plan Projects

Planning:

The picture emerging out from the progress achieved so far in respect of investigation and preparation of reports for the second Plan projects is far from satisfactory. Out of 215 schemes included in the second Plan only 69 have been sanctioned. Project reports for only 132 schemes have been received and a large number are still in the process of investigation. With this state of affairs at the end of the third year of the second Plan it is hardly possible to choose the best of the schemes in a region or to adopt the best plan of water utilisation in a basin. In order to avoid the repetition of such a state, the Planning Commission addressed the States in March, 1957 to set up investigation units and take up immediately investigation of schemes for the third Plan so that sufficient number of fully investigated schemes are available before the end of the second Plan.

Almost all the major States have since set up investigation units in response to Planning Commission's communication and it is hoped that this will help in completion of reports in time for the third Plan.

Scrutiny

The total size of the third Plan or relative emphasis that will be placed on different sectors cannot be forecast with any degree of accuracy at this stage. But according to the indication given by the Planning Commission the third Plan will be significantly larger than the second Plan, and the irrigation sector may be of the order of one thousand crores. It is presumed that the same procedure for the scrutiny of the projects will be adopted for the third Five Year Plan as done in the case of second Five-Year Plan. The likely break up of the plan will be as given below :—

	Rs. Crores
1. Projects included in first Plan and continuing in 3rd plan.	125.65
2. Projects included in 2nd Plan and continuing in 3rd Plan (costing less than Rs. 10 crores).	282.71
3. Projects included in 2nd Plan and continuing in 3rd Plan (costing less than Rs. 10 crores).	43.83
4. Projects likely to be included in 3rd Plan (costing more than Rs. 10 crores.)	371.12
5. Projects likely to be included in 3rd Plan (costing more than Rs. 1 crore and less than Rs. 10 crores).	208.85
6. Projects likely to be included in 3rd Plan (costing less than Rs. 1 crore.)	50.00
Total	1082.18

New Schemes costing about Rs. 630 crores are likely to be included in the third Plan. Thus according to the size of the third Plan as envisaged at present, Central Water and Power Commission shall have to shoulder greater responsibilities in scrutinising the projects and processing then through the Technical Advisory Committee.

It is hoped that the projects for the third Plan would start coming in for technical scrutiny from the beginning of the 4th year of the second Plan and that at the time of formulation of the next plan Planning Commission shall have sufficient schemes fully investigated and scrutinised for inclusion in the third Plan.

Table 1
ECONOMY EFFECTED ON THE SECOND PLAN IRRIGATION PROJECTS FOR WHICH C. W. & P.'S EXAMINATION IS COMPLETE

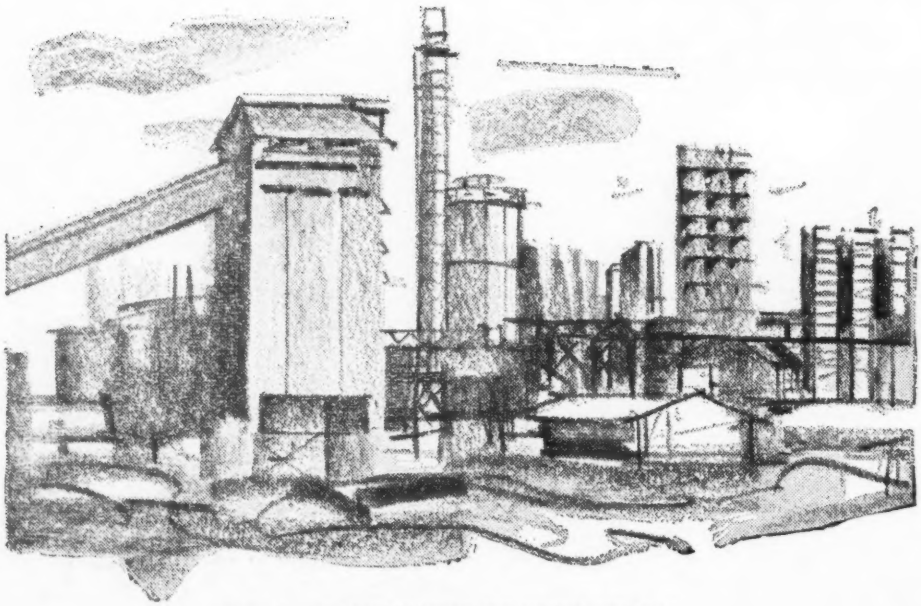
Sl. No.	*Name of State*	*No. of projects for which final comments have been sent to Adv. Committee.*	*Projects costing less than Rs. one crore each*		*Projects costing between one and five crores each*		*Projects costing above Rs. five crores each*		*REMARKS*
			Total cost of projects Rs. crores	*Saving effected Rs. crores*	*Total cost of projects Rs. crores*	*Saving effected Rs. crores*	*Total cost of projects Rs. Crores*	*Saving effected Rs. Rs. crores*	
1	2	3	4	5	6	7	8	9	10
1.	Andhra Pradesh	9	1.78	0.007	-	-	21.90	-	
2.	Assam	-	-	-	-	-	-	-	
3.	Bihar	11+3*	5.48 (11+Morwe)	0.21	3.20 (Badua only)	.50	12.03	1.07	*Three schemes are Sone Barrage, Morwe & Badua for which though final comments have not been drawn but economy effected in preliminary comments as accepted by C. E. is given.
4.	Bombay	18	3.81	0.02	8.40	.16	69.05	6.92	
5.	Jammu & Kashmir	-	-	-	-	-	-	-	
6.	Kerala	4	1.85	-	3.48	.05	-	-	
7.	Madhya Pradesh	7	2.21	-	-	-	15.21	-	
8.	Madras	2	0.69	-	1.57	-	-	-	
9.	Mysore	7	2.49	0.05	2.50	-	9.70	0.10	
10.	Orissa	2	.53	-	4.66	.27	-	-	
11.	Punjab	2	.48	0.02	1.05	·61	-	-	
12.	Rajasthan	8	2.62	0.35	4.26	0.07	-	-	
13.	Uttar Pradesh	8	1.85	-	7.07	.11	9.84	-	
14.	West Bengal	3	0.72	-	-	-	25.26	1.11	
	Total	81+3=84	24.51	0.657	36.19	1.77	162.99	9.20	Total cost Rs. 223.69 crores Saving Rs. 11.627 crores =5.2%
	Border projects Rajasthan canal	1	-	-	-	-	66.47	3.61	Total cost Rs. 290.16 crores Saving Rs. 15.237 crores= 5.24%
	Grand Total	81+4=85	24.51	.657	36.19	1.77	229.46	12.81	

DURGAPUR
COKE OVEN PLANT

the basis for many industries

An event of great significance, the inauguration of the Durgapur Coke Oven Plant by the President, Dr. Rajendra Prasad, on March 14, 1959, is yet another proud landmark in West Bengal's and indeed India's progress towards industrial self-sufficiency. A major project in the Second Five Year Plan, the Coke Oven Plant together with its ancillary units is expected to cost about Rs. 14 crores. With an installed production capacity of 325,000 tons of coke per year, the Plant will supply a substantial part of the fuel requirements of various industries in the Durgapur industrial area. Apart from coke the integrated unit will also manufacture a wide range of by-products, yielded during the basic process, including Ammonia, Sulphuric acid, Benzene and coal tar. The gases yielded by the ovens will help to feed the Thermal Power Station which again is a part of the whole project and various engineering industries and will be piped to Calcutta to supplement the city's inadequate supply. Not only is the integrated Coke Oven Plant a vitally important industrial undertaking but it is also a much needed source of employment for thousands. When in full production the unit will provide full-time work for several thousand people, the whole year round.

The Durgapur Coke Oven Plant is an industry
in itself and more
—it is the basis of many more industries to come.



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WBGG-9

Organisational Set-up of the Central Water and Power Commission

By K. C. KHATRI

The Central Water and Power Commission—a Central Government organisation constituted on the 21st April, 1951 under the Ministry of Natural Resources and Scientific Research and at present under the administrative control of the Ministry of Irrigation and Power—is charged with the general responsibility of initiating, coordinating and furthering, in consultation with the State Governments concerned, schemes for the control, conservation and utilisation of water resources, throughout the country, for purposes of flood control, irrigation, navigation and waterpower generation, as well as schemes of thermal power development, and also schemes of transmission and utilisation of electric energy throughout the country. It has got three Wings, namely the Water Wing, the Power Wing and the Flood Wing.

Water Wing

The origin of the Water Wing of the Central Water and Power Commission can be traced back to the days when the Civil Secretariat of the Government of India was established under the British regime. Irrigation continued to be dealt with in the Civil Works Branch of its Public Works Department until a separate full-fledged Branch was set up in that Department on the creation of the office of Inspector General of Irrigation in January, 1867. This office was held from time to time, depending upon the exigencies of work, by officers of different ranks in the Public Works Department, and towards the end of the nineteenth century it came to be held by the Public Works Secretary himself. In 1906, however, the office of the Inspector-General of Irrigation was separated from that of the Public Works Secretary in view of the anticipated increase in the former's duties and responsibilities on account of the programme of an enormous expansion of irrigation in the country for the next two decades.

With the enactment of the Government of India Act 1919 'irrigation' became a provincial but reserved subject. This constitutional development led to the abolition of the post of Inspector-General of Irrigation on 31-5-1923. The post of Consulting Engineer to the Government of India was, however, created, with effect from 1-6-1923 and the Consulting Engineer took over not only the functions of the Inspector-General of Irrigation but also the duties and responsibilities of the Public Works Secretary in regard to technical, advisory and estate work.

Subsequently, it was felt that the Government of India was dependent entirely on the advice of a single officer in their Consulting Engineer, who, howsoever able he might be, had spent all his service in one Province and might not therefore be competent to handle all the projects submitted to him for examination. This gave birth to the idea of having an Irrigation Board before which could be laid all schemes submitted to the Government of India by the local Governments. Thus, the Central Board of Irrigation (now styled as Central Board of Irrigation and Power) was formed on 1st January, 1927, with the Consulting Engineer to the Government of India and the Chief Engineers in charge of irrigation in the Provinces as Members.

The post of Consulting Engineer lasted for about 9 years only, since it was abolished on 31-3-1932 for the reason that no further economic development of irrigation appeared practicable in the near future owing to the financial—stringency and economic depression obtaining in the country in those days.

When irrigation became a provincial subject under the Government of India Act, 1935, every administrative unit in the country became competent to undertake whatever legislative or administrative measures it liked with respect to waterways passing through its territories. The power to consider and settle disputes between two or more administrative units over their rights in the waters of an inter-State river, however, was vested in the Governor General of India. Considering the recommendations made in this behalf by the Central Board of Irrigation and owing to the difficulties experienced in dealing with disputes over water rights and other technical questions relating to large irrigation projects, the Government of India created again the post of Consulting Engineer for Waterways in January, 1944.

The Central Board of Irrigation also considered that unilateral action by an administrative unit concerning its portion of a waterway might have an adverse effect on neighbouring units. To make the fullest and most economical use of the waterways and their waters; the Board adopted a Resolution in November, 1943, recommending the setting up of one technical authority which would collect and collate the necessary data for the information and use of the Government of India and the administrative units. The Government of India also felt the necessity for such an expert body, considering that the system of referring projects and problems to the Central Board of Irrigation suffered from certain defects. Consequently, it was decided by the Government of India in the Labour Department on 5th April, 1945 to constitute a strong technical organisation styled as the Central Waterways, Irrigation and Navigation Commission which was charged with the general responsibility for initiating, coordinating and pressing forward schemes of control, regulation and utilisation of water and

waterways in consultation with Provincial and State Governments concerned and to undertake, if so required, the construction of any such scheme on behalf of the Government of India. Subsequently the Government of India reviewed the position regarding the four organisations dealing at that time with electricity and water development, viz. the office of the Electrical Commissioner with the Government of India, the Central Technical Power Board, the office of the Consulting Engineer for Waterways and Irrigation, and the Central Waterways, Irrigation and Navigation Commission, and it was decided to replace these four organisations by two organisations to be known as the Central Electricity Commission and the Central Waterpower Irrigation and Navigation Commission. The Central Waterpower Irrigation and Navigation Commission, which was constituted under the Ministry of Works, Mines and Power on 17th January, 1948, took over the functions assigned to the Consulting Engineer for Waterways and Irrigation and the Central Waterways, Irrigation and Navigation Commission, and in addition was made responsible for the functions relating to hydro-eoectric power generation previously performed by the Central Technical Power Board. Tne Chairman of this Commission was also ex-officio Consulting Engineer for Waterways, Irrigation and Navigation. In April, 1951 the Government of India in the Ministry of Natural Resources and Scientific Research, in the interest of economy and efficiency, decided to amalgamate the Central Waterpower, Irrigation and Navigation Commission and the Central Electricity Commission to form respectively the Water Wing and the Power Wing of an organisation styled as the Central Water and Power Commission. This decision provided for the composition of the Commission as consisting of a Chairman and four Members, two of them directing the Water Wing and the other two directing the Power Wing—the Chairman being ex-officio Consulting Engineer to the Government of India. This ex-officio status of the Chairman did not continue after the Commission had been given a reorganised set-up in December, 1953 as it was considered more appropriate that the Commission as a body should function as consultants to the Government of India.

Power Wing

The Central Electricity Commission, which is at present known as the Power Wing of the Central Water and Power Commission, was formed in 1948 by amalgamating the offices of the Electrical Commissioner with the Government of India and the Central Technical Power Board. The Electrical Commissioner's office was set up in January, 1941 under the late Supply Department in order to ensure the maintenance of efficiency of the Electricity Supply Undertakings in India during the War, as well as the reliability and security of the electrical systems of the Ordnance Factories and other Factories engaged on important war work. The idea of setting up the Central Technical Power Board had originally mooted at a meeting of the Policy Committee No. 3C (Public Works and Electric Power) of the Post-war Re-construction Committee of the Council, which was held in Delhi in October, 1943 where representatives from all the then Provinces of British India and five of the major Princely States were invited so that they could meet and give their views on the vital question of post-war Development of Electricity in India as a whole. Subsequently, a technical conference of Postwar Electric Power Development was held in Calcutta in January, 1944 with the main purpose of enabling leading engineers in India to appreciate the magnitude of the problem of electrical development, and to forward recommendations to the Government of India on the advisability or otherwise of forming a Central Technical Advisory Panel to help electrical development. Based on Resolution No. 13 passed by that Conference, the Central Technical Power Board was set up by the Government of India on 8th November, 1944. It was charged with the general responsibility for initiating, coordinating and pressing forward schemes of electric power development (whether thermal, diesel. or hydro-electric) and its utilisation throughout the country. It was mainly intended to plan large power projects in consultation with Provincial and State Governments concerned and to undertake, if so required, the construction of any such schemes.

Flood Wing

The disastrous floods of 1954 as also the tragedy and sufferrings that followed pointed to the need for tackling the flood problem in the country on the basis of national emergency and for devising measures—immediate, short-term and long-term—to minimise damage to life and property caused by the floods. To ensure that flood control measures were formulated and carried out expeditiously, such of the States as were liable to frequent floods were requested to constitute Flood Control Boards. Thus there are at present Flood Control Boards in 13 States viz. Andhra Pradesh, Assam, Bihar, Bombay, Jammu and Kashmir, Kerala, Madhya Pradesh, Mysore, Orissa, Punjab, Rajasthan, U. P., and West Bengal. The country has also been divided into four regions each of which is served by a River Commission. The four River Commissions are : one for the Ganga Basin, the second for the Bramhaputra Basin, the third for the North-Western Rivers and the fourth for the Central India and Peninsula Rivers. These River Commissions are charged with the responsibility of coordinating the flood control efforts of the State Governments represented on them. On the National Plan, a Central Flood Control Board was constituted in order to coordinate the efforts of the State Governments and the River Commissions, and to draw up a national Flood Control Programme having regard to available finance and technical personnel. For the performance of technical work relating to or emanating from the functions of the Central Flood Control Board, the Govenment of India decided to strengthen the Central Water and Power Commission. Accordingly, a Flood Wing was created in the Commission in September, 1954 and was charged with the following responsibilities and functions :—

(*i*) to draw integrated plans for flood control of the Ganga, the Brahmaputra and other river basins in the country ;

(*ii*) to make an exhaustive study of silt in various rivers with reference to size and quantity and

to analyse results; to coordinate the work undertaken by State Laboratories and Field Investigation Parties in connection with the flood control; and to locate and test construction materials for flood control works and to evolve suitable substitute materials to stone wherever stone is costly or difficult to obtain at the site of flood works; and

(*iii*) to act as Secretariat to the Central Flood Control Board and River Commissions.

Composition of the Commission

The Commission consists of a Chairman and four Members, two each directing the Water Wing and the Power Wing. There are two Chief Engineers in charge of the Flood Wing. The business of the Commission is transacted at its meetings presided over by the Chairman, and also by circulation of relevant papers to the Members and the Chairman.

The Commission is assisted in the discharge of its responsibilities by a number of functional Directorates each dealing with specific aspects of water and power development, namely, planning, design, research, etc. It has also a few Directorates to deal, with ad-hoc assignments such as technical examination of projects for inclusion in Five-Year Plans, plants and machinery as well as vital cnstruction materials like steel, cement and coal required for river valley projects and thermal power projects, etc. In the Water and Flood Wings of the Commission, there is a separate Directorate dealing with administration and coordination work, whereas in the Power Wing all administration work is being attended to by a separate Division.

Field investigations, basic as well as preliminary and detailed, are carried out by the Commission through its various circles having adequate field establishment. The Commission has also organised a publicity unit to publicise the programme and progress of the river valley projects in the country and to educate the public with respect to the benefits accruing therefrom. It has also a well-equipped Library and Information Bureau, catering to the needs of the Central and State Governments in regard to technical literature and books, disseminating the results of research activity at various water and power research stations in India, and arranging the interchange of technical literature with other countries.

The Directorates, Circles and Sections of the Commission, their respective functions and the allocation of work among the Members and Chief Engineers are as given below :—

Water Wing

Member (Planning & Investigation) :

1. Waterways, Irrigation and Navigation Directorate—Assessment of irrigation potential, collection of irrigation statistics, preparation of waterways and inland navigation reports, inter-State Water disputes etc.

2. Technical Examination Directorate—Technical examination of projects prepared by the State Governments for inclusion in the Five-Year Plans.

3. Union Territories Circle—Coordination of irrigation and flood control schemes in the Union Territories.

4. Trisuli Hydro-Electric Project Circle—This Circle is responsible for construction of the Trisuli hydro-electric project in Nepal.

5. Seminar Section—To arrange Engineers' seminars for study and discussion of technical and procedural problems.

6. Bhagirath Section—To bring out the monthly journal "Bhagirath" giving information on water and power schemes etc.

7. Publicity Section—To arrange publicity of water and power schemes through different media.

8. Publication Section—To handle all work pertaining to publications brought out by the Commission.

Member (Design & Research) :

1. Dams Directorate—Preparation, scrutiny and study of designs of dams and appurtenent works.

2. Canals Directorate—Preparation, scrutiny and study of designs of canal structures including Head Works.

3. Plant and Machinery Directorate—Coordination of plant and machinery for use on water and power projects, coordination of construction materils like steel, cement and coal, etc.

   Technical Training Centres at Kotah and Nagarjunasagar—These Centres are responsible for training Indian personnel in the operation and maintenance of heavy earth-movng and other construction equipments used in the multi-purpose River Valley Schemes.

4. Cost Control Cell—Development of a proper system of cost accounting for river valley projects and coordination of cost accounting work of such projects.

5. Central Water and Power Research Station, Poona—To conduct research on basic and ad-hoc water and power problems throuh model studies and other methods.

6. Library and Information Bureau—Loan of technical literature and books, dissemination of technical information, etc.

Power Wing

Member (Hydro-Electric) :

1. Hydro-Electric Directorate—Preparation and scrutiny of hydro-electric schemes including specifications, designs, detailed layout, etc. for the plants and equipments required therefor.

2. Transmission Directorate—Layouts and designs of main and secondary transmission lines and networks, structural designs of transmission lines etc.
3. Technical Examination, Coordination and Research Directorate—Technical examination of projects prepared by State Governments for inclusion in the Five Year Plans, collection and coordination of technical information, telcommunication, coordination and research on transformer oils.
4. Union Territories—Coordination and advice in respect of Power schemes in the Union Territories.

Member (Utilization)

1. Load Survey and Load Development Directorate —To undertake comprehensive surveys in connection with the assessment of electric power for various project areas, State administration, etc.
2. Plant Construction and Procurement Directorate —To plan and erect steam power stations, diesel power stations, etc. and to assist State Governments and electricity supply industries in emergency procurement of electrical plants and equipments. Allocation of materials such as steel, coal etc.—in short supply—to the Power Projects and Electricity Supply Utilities.
3. Rural Electrification Directorate—To collect, compile and disseminate information on methods and practices in foreign countries in the field of rural electrification development, to scrutinise rural electrification schemes, etc.
4. Commercial Directorate—To advise the Central and State Governments in regard to Indian Electricity Act, 1910, Indian Electricity Rules, 1946, and the Electricity (Supply) Act, 1958 ; to collect, analyse and publish financial statistics and data on potential use of electric power in various industries.
5. System Planning Directorate—Preparation of codes for practices of "the safe design, construction, operation and maintenance of electrical installations".
6. Administration Division—To deal with all establishment matters.

The work of following Directorates in the Power Wing is being looked after directly by the Chirman:—

1. Thermal Directorate—Development of designs and layouts of new thermal power stations, modifications and improvements of the existing power stations, research into fuels, inspection, testing and approval of thermal power plant and machinery and matters connected therewith.
2. Planning Cell—Site investigation, preparation of specifications for the Neyveli Thermal Station and Thermal Power Plants to be set up for meeting the requirements of power of heavy machine building plant and foundry forge at Ranchi as well as the coal mining machinery plant at Durgapur.
3. Foreign Exchange Cell—Foreign Exchange requirements of Power Projects.

Flood Wing

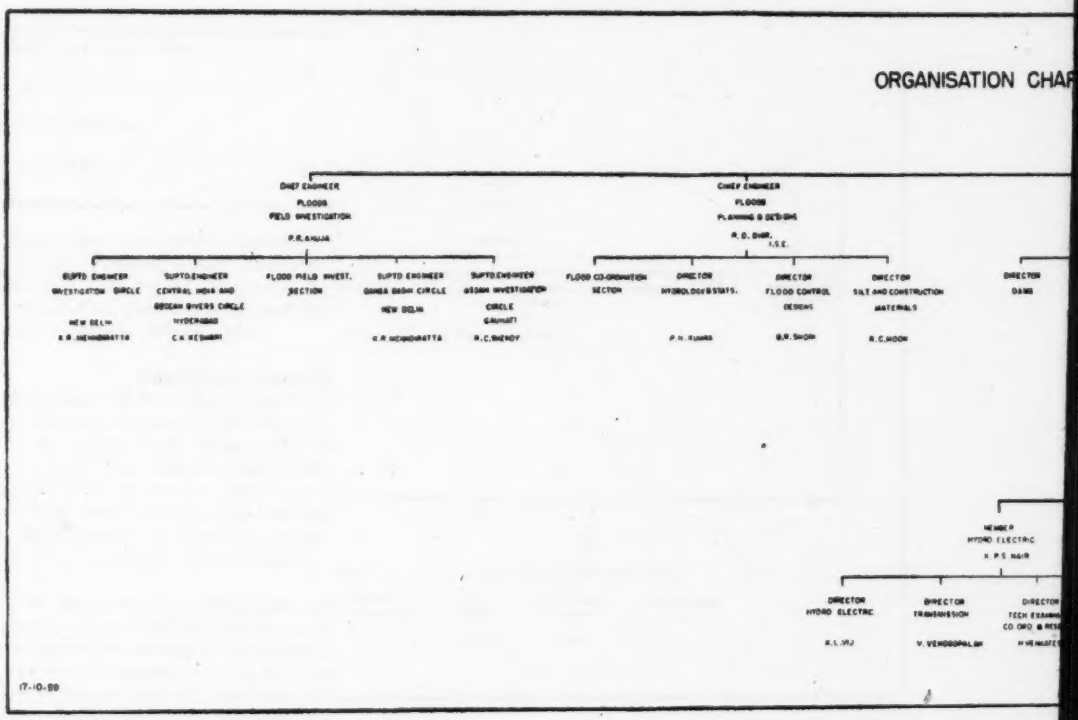
Chief Engineer, Flood (Planning & Designs)

1. Hydrology and Statistics Directorate—To deal with the hydrological and related aspects pertaining o water resources development in general and flood contol in particular.
2. Flood Control Designs Directorate—To scrutinise major flood control schemes sent by the States, to advise the Central Government in regard to loan assistance to States for their flood control schemes, etc.
3. Silt and Construction Materials Directorate— Exhaustive studies of silt in various rivers and their tributaries both with reference to size and quantity, locating and testing material which is required for construction of flood control works and coordinating the work undertaken by the State Laboratories and Field Invesigation parties.
4. Flood Control Coordination Section—To coordinate the work of the above Directorates and to assist the Chief Engineer F (P & D).

Chief Engineer, Flood Field Investigation :

1. Investigation Circle—Preliminary and detailed investigations and preparation of project reports, coordination of flood control schemes in Jammu and Kashmir and Madhya Pradesh.
2. Central India and Deccan Rivers Circle—Collection of hydrological data and conducting of all preliminary surveys for purposes of flood control, assessment of irrigation potential and preparation of basin-wise reports for Narmada, Tapi, Godavari Krishna and Pennar rivers and investigation of Iddiki Project in Kerala.
3. Ganga Basin Circle—To collect all hydrological and other technical data in respect of river systems in U.P., Bihar, West Bengal and Orissa for preparation of data books on different river basins.
4. Assam Investigation Circle—To collect hydrological and other technical data in respect of Brahmaputra and its tributaries, to make preliminary and detailed investigations of storage sites, etc.
5. Flood Field Investigation Section—To provide assistance in secretarial work to the Chief Engineer.

Administration and Coordination Directorate—The Administration and Coordination Directorate is resopnsible for dealing with administrative and establish-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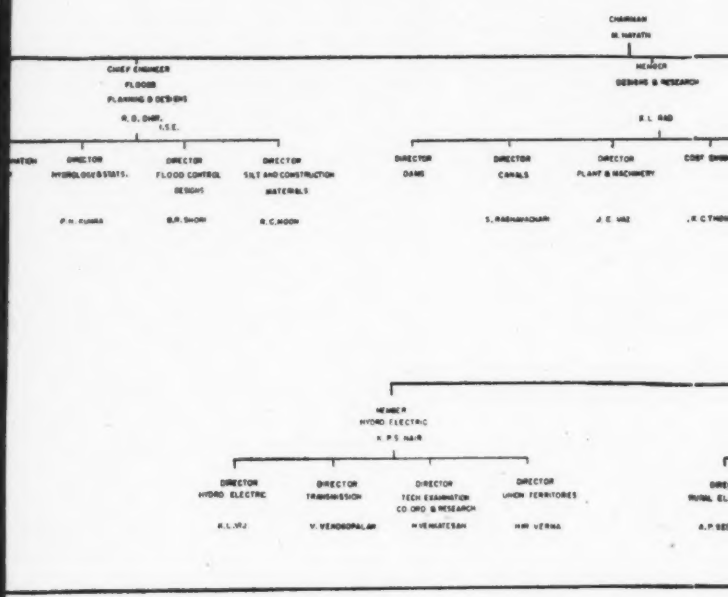

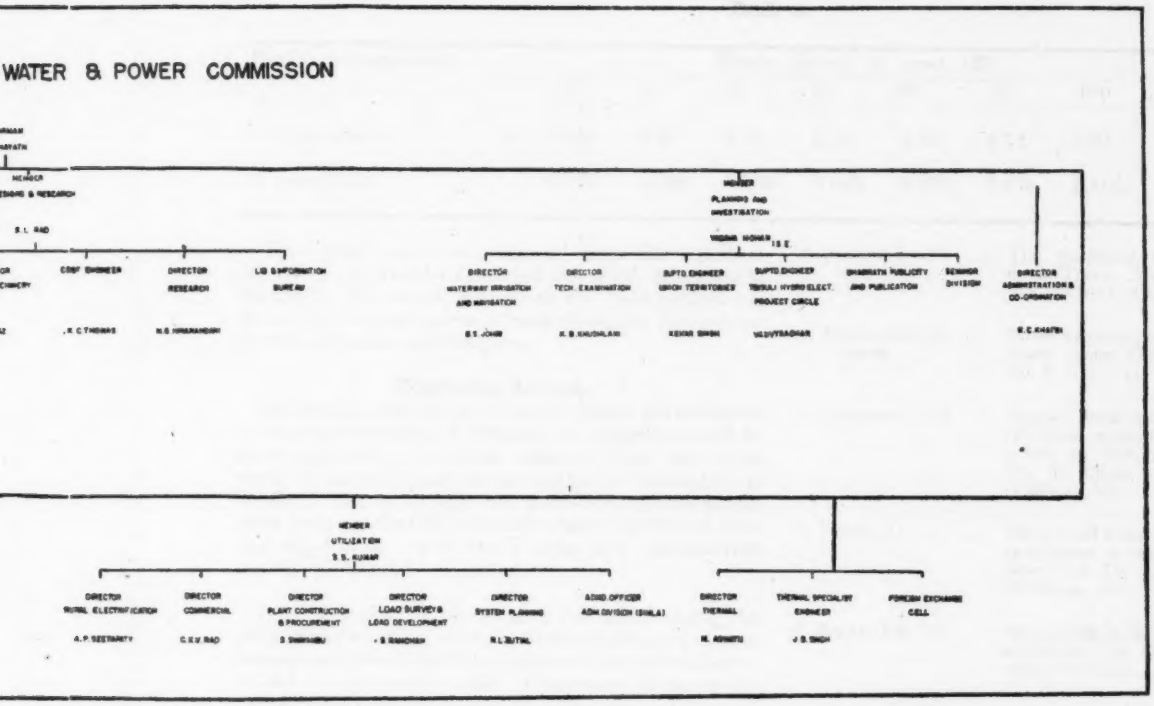
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PLANNING AND INVESTIGATION
DIRECTOR RESEARCH
DIRECTOR TECH. EXAMINATION
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DIRECTOR RURAL ELECTRIFICATION
DIRECTOR COMMERCIAL
DIRECTOR PLANT CONSTRUCTION & PROCUREMENT
DIRECTOR LOAD SURVEYS & LOAD DEVELOPMENT
DIRECTOR SYSTEM PLANNING
DIRECTOR THERMAL
THERMAL SPECIALIST ENGINEER
FOREIGN EXCHANGE CELL

ment matters in the Water and Flood Wings and the coordination of technical work pertaining to various Directorates. In addition, the work relating to the training of officers and requriements of foreign experts under various foreign aid progrmmes, training of fresh engineering graduates as well as of serving engineers of States, deputation of officers abroad, preparing replies to Parliament questions, preparation of progress reports of the C.W.&P.C. etc. is also the responsibility of this Directorate. This Directorate works directly under the Chairman, but in cases where certain specific powers have been delegated and duties entrusted to Members/Chief Engineers, orders of the concerned Member/Chief Engineer are obtained.

Director (A & C) also acts as Secretary to the Commission and is Organisation and Methods Officer, Vigilance Officer and Security Officer in the Commission.

[*Continued from page* 28

A Sampling Approach to the Estimation of Floods

Table 3.

Peak flood magnitudes.	*Return period in years (T)*								
	10	15	20	25	30	50	100	200	500
In lakh cusecs.	2.35	2.81	3.19	3.51	3.79	4.72	6.33	8.48	12.48
In logarithm.	5.372	5.449	5.503	5.545	5.579	5.679	5.801	5.928	6.096

These final estimates obtained from the equation (3) are represented by the thick line in the diagrams in Figure 3. This would bring out the comparison between the final estimates of peak flood and those given by the different sub-samples.

Concluding Remarks

Estimation of flood for a specific return period based on the central value of different sub-samples would be more accourate than those obtained from the single series of data, so long as the method of estimation is similar. That is to say, the same conclusions would have been reached if the analysis were carried out with the log-normal or Foster's type III distribution instead of Gumbel's distribution.

It is, therefore, suggested that instead of basing the estimation procedure with the observed series of data, a few sub-samples should be considered out of the observed set as discussed earlier. Eastimate of floods for different return periods may then be obtained for each of the sub-samples. The average value of the different estimates from different sub-samples may be finally adopted.

Acknowledgement

Authors wish to record their thanks to Shri H. Ramamurthy, E. A. D. (Statistics) for his helpful suggestion in the preparation of this paper.

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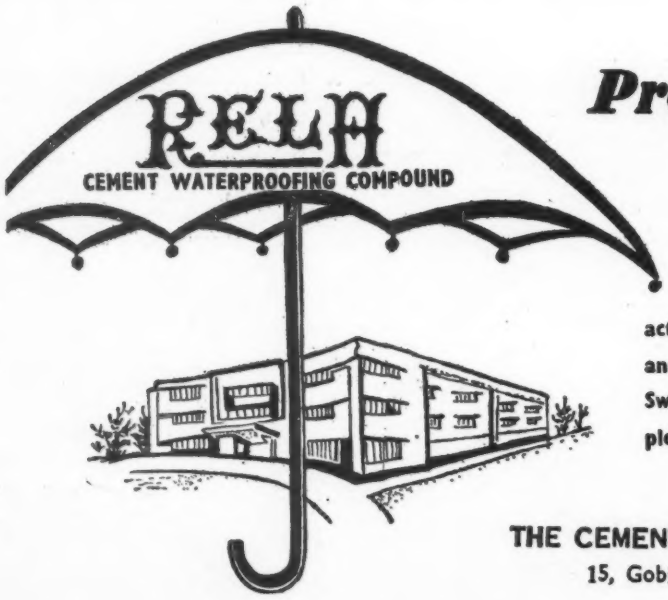

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Technical Notes & News

Trends in Hydro-Electric Power

At the Canadian Sectional Meeting of the World Power Conference held in Montreal in September, 1958, a special section was devoted for generation of power by hydraulic means. A number of Papers under this Section dealt with recent developments in the design of hydraulic machinery and what is of greater importance is that much attention was given during discussions to the trend of contemporary thought on the present and prospective role of water power in the rapidly changing power economy of the world. Most of the Papers highlighted the theme of integration of water power development with other resources, and a number of Papers also discussed the question of the economic evaluation of hydro potential in an integrated power system.

Some of the Papers discussed the specialised standpoints of pumped storage—a feature which may well become of far reaching importance in the power supply pattern of the future.

A cross section of the important Papers dealing with hydro electric power development are summarised below.

Power Trends in various Countries

The problem of the integration of power resources is well analysed in a paper "Economic Aspects of Hydro Power Development on the Electricity Supply in Austria" by Prof. Dr. O. Vas. Austria. It has ample water-power resources, largely run-of-river power on the Danube, but there are also valuable storage sites in the Alpine and sub-Alpine regions. Supplies of indigenous fuels are restricted and are confined to lignite, naphtha and natural gas. The paper describes an analysis undertaken to determine the type and capacity of new plant required to meet a doubling of demand within the next ten years—a further 10,900 GWh per annum. Load-duration curves were drawn for the six winter months, four summer months, and two transition months (April and September), and the role of each form of power examined in relation to these curves. Thermal power presented the obvious advantage of lower initial construction cost, but the factor of higher running cost was aggravated by the comparative scarcity of indigenous fuels. Capital costs for hydro-electric schemes are assessed in Austria not on the installed capacity but on the available annual output. On this basis, run-of-river plants showed specific costs of about 2 Austrian schillings per kWh per annum, and storage plants about 4 schillings on a basis of 3,000 utilisation hours. The most economic balance for new plant for the Austrian system is found to be: run-of-river 1,090 MW, 6,760 GWh; storage 900 MW, 2,140 GWh; thermal 600 MW, 2,040 GWh. These figures show that 61% of new production will come from run-of-river plants, 20% from storage plants and 19% from thermal plants, and to secure this result 80 MW of storage capacity and 55 MW of thermal capacity will be required for every 100 MW of run-of-river capacity.

Quite a different energy pattern is to be found in Italy, as disclosed in a paper "Les Perspectives du Development do a Production 'd Energie Hydroelectrique en Italie" by Dott. A. Camponeschi and Dott. Ing. U. Beltrami. Although Italy produces more hydro-electric power than any other country in Europe it is not so favoured naturally as certain other countries. The catchment areas are not very extensive and in many cases their mean elevation is comparatively low. Seasonal variations in flow are usually high and the average annual flow of most catchments is moderate—only the Po exceeds 1,000 cu. m. per sec. Furthermore, sites for large storage reservoirs are fewer than in Switzerland and France. Due to these conditions the individual stations have a low annual productibility, and in fact only three exceed 600 GWh per annum. Long transmission distances constitute a further unfavourable factor.

To these considerations must be added the fact that of the total hydro-electric resources regarded as economically exploitable (50,000 GWh) about 68% have already been developed. A progressive advance in the proportion of thermal power is therefore envisaged, which is expected to outstrip hydro capacity by about 1965-70. The role of water power will gradually change from base load to peak load, and although new resources will be developed it is thought that attention will be concentrated primarily on making the most effective use of existing plants and of supplementing daily and weekly as well as seasonal storage capacity.

A somewhat more optimistic note is struck in a second Italian paper "Le Role des Utilisations Hydrauliques pour le Developpement de la Production de l'Energie Electrique en Italie" by Prof. Ing. P. Froxini and Prof. L. Gherardelli in which the conclusion is reached that through a more rational and comprehensive utilisation of hydro resources a total hydro-electric production of some 65,000 GWh should be realisable —or about double the present production.

Conditions in Brazil are surveyed in a paper "A Survey of Electrical Power Generation Trends in Brazil" by J. F. Pinto. Brazil's water-power resources are con-

servatively estimated at 20,000 MW, derived from eight basins, each of which is briefly studied in the paper. Indigenous fuels are limited and of poor quality, so that thermal plants have to rely mainly on imported fuels. Nevertheless, the installation of thermal plants received some impetus after the war due to their lower capital cost, the speed with which they could be erected, and a favourable exchange rate for imported fuels. The fuel position, however, caused a reorientation towards hydro power from 1953 onwards. The future possibilities of nuclear power are also examined in the light of available deposits of fissionable ores.

Tasmania is a case of an island which relies entirely on its hydro-electric resources, and A. W. Knight, in a paper "Economic Trends of Power Development in Tasmania," states that this will remain the case for a considerable time to come. The western half of the state is practically undeveloped and is estimated to be capable of producing another 7,500 GWh per annum in addition to the 3,880 GWh which will be produced when works now under construction are completed. The rising cost of hydro-electric development has been mainly due to inflation, and improvements in methods and materials have meant that the price of electricity has not risen in the same proportion. Due to transport requirements the capital cost of a thermal station in Tasmania would be nearly as much as that of a hydro station, and in any event the hydraulic resources are such that balancing with thermal power will be unnecessary for many years. Nuclear power is not likely to be attractive before about 1970.

In India, according to a paper "Economic Trends in the Production of Hydro-Electric Energy in India" by M. Hayath and K. L. Vij, economic considerations point to the conclusion that the bulk of energy production during the next two or three decades must be derived from hydro resources. A table giving salient features of completed single-purpose and multi purpose schemes, together with a map, is included in the paper.

An interesting study of power development in Japan is made in a paper "Economic Tendency in Electric Power Development in Japan" by N. Mitani, T. Fujii, and M. Ishii. The country's power resources consist mainly of about 20,000 million tons of coal, generally unfavourable for mining, and hydro-electric capacity estimated at 30,000 MW. The paper traces the development of these resources over the past 70 years. The initial regime was one of small independent hydro and thermal plants, originally solely for lighting but later also for private industrial power. This was succeeded by a hydro development period culminating in 1930, when hydro capacity had reached 2,950 MW and thermal capacity 1,550 MW. Next came a hydro-thermal combination period; by 1950 hydro capacity had become 6,750 MW and thermal capacity 4,010 MW, and by 1956 the respective figures were 9,600 MW and 5,850 MW.

The pattern of the future is likely to be determined by the practical limitations to future hydro-electric development and by the rise of the large high-efficiency thermal plant. Japan has a high annual precipitation—an average of 1,600 mm.—but as the country is mountainous and narrow the rivers are short and steep and lack sites for storage reservoirs. These conditions favour run-of-river development, but as the rivers in this tropical region are characterised by heavy flows of short duration it is necessary to build storage reservoirs wherever feasible. The future is therefore likely to see a swing over to a thermal-based power economy, using high-efficiency thermal plants assisted by run-of-river plants for base load and storage hydro plants for the peaks. Pumped storage is receiving close study, and there are already four such plants—three in operation and one under construction—of capacities ranging from 2,340 to 43,600 kW.

In Portugal the power-supply problem is subject to certain special considerations, which are admirably set out in a paper "Quelques Aspects Economiques Rapport avec la Co-ordination de l'Exploitation et la Planification des Ressources d'Energie Electrique au Portugal" by Ing. F. I. Concalves and Ing. J. C. Morais. Portugal possesses hydraulic resources estimated at 12 to 14 GWh in an average year, but its fuel resources are scanty and of poor quality. Its power system is therefore based essentially on water power, thermal stations being reserved for use in dry years and during exceptionally dry periods in more normal years. During such periods thermal stations are used on base load; they are never needed for peaking as it has proved more economical to provide over capacity in the hydroelectric stations. This excess capacity is called for by the great irregularity in flow of the Portugese rivers, both in the course of a year and between one year and another, so that it is advisable to be able to take advantage of the excess flow in wet years. This irregularity has also called for the provision of abundant storage capacity, much of which is for inter-annual regulation. By a Nationalisation Law of 1951 three Authorities were established to control the development of three main river basins—the Zezere, the Cavado and the Douro—and a National Load Dispatching Authority was set up to control the bulk transmission of power throughout the country and to co-ordinate generation. The paper describes in some detail how this organisation deals with the economic problems of system operation and of future planning in the light of the special circumstances.

Conditions in Russia are recounted in two papers. One of these, "The Role of Water Power in the Formation of Large Power Systems and Consolidated System in the Soviet Union" by L. O. Saatchian and G. N. Lyalik, discusses the value of hydro-electric plant in what are termed "consolidated' power systems—obviously large systems in which the maximum benefits are derived from integration and interconnection—and these benefits are illustrated by reference to the two largest systems in the Soviet Union—the European and the Central Siberian power systems. Russian water-power resources are appraised from the economic standpoint

in the second paper "A Comparative Cost Estimate and Prospects for Harnessing the Water Power Resources in the Eastern Regions of the U. S. S. R." by Prof. A. N. Voznesenski and A.A. Beschinski.

Hydro-Thermal Correlation

Several of the foregoing papers will be seen to have discussed the economic integration of combined hydro and thermal systems; in a number of other papers, this forms the principal theme. One of the most important of these papers is "Economic Integration of Coalfired, Nuclear and Hydraulic Generation of Electricity with Special Reference to Scotland" by J. Henderson and C. L. C. Allan, as it covers the whole gamut of water power, coal-generated power, nuclear energy, and pumped storage—all of which find, or will find, their place in the Scottish system. The authors commence by examining in turn the general characteristics of water power (including pumped storage), coal-fired stations, and nuclear power from the standpoint of their integration into a combined system, and then apply their conclusions to conditions in Scotland. Electricity supply in Scotland is provided by two Boards—The North of Scotland Hydro-Electric Board whose resources are mainly hydraulic, and The South of Scotland Electricity Board whose resources are mainly thermal—and the correct economic policy for the future is seen to lie in the close integration of hydro, thermal and nuclear power with an agreed policy of extensions. This paper is too full of material for any summary to do justice to it, and it is best studied in the original.

A paper on Uruguay entitled "Production of Electrical Energy in Uruguay—Development of the Hydraulic-Thermal System Rio Negro—Montevideo" by C. A. Giavi is of distinct value in its approach to the hydro-thermal integration. Uruguay's power system has hitherto been based on thermal stations, but as these stations depend on coal and fuel oil imported at high cost steps have been taken to develop the country's rivers, although their characteristics are not particularly favourable. The largest river is the Rio Negro, and a 128 MVA plant has already been built at Rincon del Bonete; a second, of 108 MVA capacity, is under construction at Rincon de Baygorria, and further stations are planned at Paso del Puerto and Yapeyu. Two methods of operating the hydro-thermal system are followed according to the available flow in the Rio Negro—"normal operation"and"water-deficit operation." In the former case the outmost use is made of hydro power, which furnishes base load, whereas in the latter case water power is reserved for the peaks. Control of water economy under water-deficit operation is effected by a family of "waterdeficit curves," which were determined for the Rincon del Bonete project.

Another case where an almost exclusively hydro system is having to increase its thermal capacity exists in Canada, and is discussed in a paper "Thermal-Hydraulic Generation Integration in Southern Manitoba and North-western Ontario" by C. G. Mills and H. Teekman. Generation in Southern Manitoba, which is controlled by the Manitoba Hydro-Electric Board and the Winnipeg Hydro-Electric System, is largely hydraulic, and in North-western Ontario, in the charge of Ontario Hydro, generation is exclusively hydraulic. The catchment areas controlled by the two provinces are so interlinked that their use has to be studied in the light of inter-provincial and international repercussions.

Consideration of the supply position in Manitoba as it exists in 1958 led to a study of two alternatives—a 240 MW hydro station at Grand Rapids 250 miles north of the load centre, or a 132 MW steam station near Brandon. Transmission costs for the hydro plant were seen to be prohibitive unless the station was loaded up as soon as completed, and for the first few years this could only be done by unloading the Winnipeg river plants. The steam station was finally chosen as it could be erected near the load centre and the unit size chosen to meet the load growth as it occurred. The steam plant would be operated until the demand justified construction of the Grand Rapids plant, and its output would then be decreased as the new hydro units came into operation. Further hydraulic sites equivalent to several hundred megawatts are available on the Nelson River, but as they are upwards of 400 miles from the southern load centre they will remain uneconomic until blocks of high-load-factor power can be picked up.

In North-western Ontario, apart from plant now under construction, there are undeveloped sites of some 467 MW capacity, some of which are known to be economic, others uneconomic, and others have not yet been fully studied. A 100 MW steam station is being built at Fort William for service in 1961 to firm up the output from plants constructed since 1955 on the English and Winnipeg Rivers and which have been deliberately over-installed for this purpose, and to form a reserve against sudden load growth.

When evaluating the economic capacity of a new hydro-electric development, Ontario Hydro uses as a criterion the cost of delivering to an assumed load centre equivalent power from a thermal plant. The most economic capacity is that for which the incremental annual cost per kilowatt equals the incremental cost of power delivered from the thermal plant, provided that the total annual cost per kilowatt is not greater than the total annual cost for the thermal plant. The paper also considers the effect of thermal capacity on the evaluation of storage, and refers to the advantages of the electrical interconnection established in 1956 between the two provinces.

A particularly interesting paper was contributed by Dr. T. Ingledow on "Integration of Gas Turbines in Hydro-Electric Systems" for this is the only paper in which the use of gas turbines in conjunction with a hydraulic system is studied in detail. After outlining the general principles of firming up hydro power by thermal power, Dr. Ingledow discusses the technical advantages of gas turbines for this service. Although

their fuel cost is somewhat higher than for an equivalent steam station their capital cost is lower, especially in the larger sizes, and they possess the important operating advantages of their ability to take full load in about 20 minutes from a cold start, and of the ease with which they can be remotely controlled. The latter facility is particularly important as a plant of this description operates for only a part of the year, and in favourable water conditions may be shut down for several years. Gas turbines therefore show important advantages over steam plant for low-load-factor operation. The author concludes his paper with a brief description of the 100 MW remote-controlled gasturbine plant which British Columbia Electric Co. Ltd. have just built at Port Mann.

Dr. Ingledow's paper leads naturally to consideration of a most interesting contribution by T. D. Stanley and G. F. Green on the "Economics of Centralised Control of Electric Generating Plants," for both Calgary Power Ltd. and B. C. Electric (represented by the two authors) have built up their systems on the basis of remote control of power stations and substations from a centralised control point. Striking economies are made in personnel, and the operating staff find the work more interesting and responsible. Operation is also more efficient, as the load dispatcher is able to view conditions on the electrical system as a whole and take immediate action. Hydraulic control can also be coordinated to make the most efficient use of water, and in some instances centralised control makes it possible to construct plants that could not otherwise be justified.

The application of centralised control to the two supply systems concerned is then described, and striking figures are given of the savings that have accrued.

Evaluation of Hydro-Electric Capacity

Certain other papers describing particular power systems are more concerned with the evaluation of hydro-electric capacity than with the integration of alternative forms of power, and one or two papers go into this question analytically. The two American papers within this section are both written from this standpoint as it affects the design of multi-purpose projects. The paper "Modern Hydro-Electric Potential Evaluation" by E. G. Nielson gives a full account of the planning methods of the U. S. Bureau of Rec amation, and "Water Resource Development in the Hells Canyon Reach of Snake River" by F. R. McCormick and F. C. Harvey, gives a similar account in the case of the Idaho Power Company. Neither paper can justly be summarised but should be read in full.

Three papers from Eastern Europe are concerned more with the analytical investigation of hydro-electric capacity. Typical of these is "Application of Sequential Analysis to Economic Evaluation of Installed Capacity by Hydro-Electric Plants" by T. Biernacki of Gdansk Technical University, Poland. The author outlines the method of sequential analysis introduced and published by A. Wald and applies it to the evaluation of the available capacity of hydro-electric plant. An actual storage type station is taken as an illustrative example and the results discussed.

A paper from Yugoslavia "Puissance Installee d'une Centrale Hydraulique etle Degred 'Utilisation de Ressources Hydroenergetiques" by Dr. Ing. H. Pozar also approaches the subject analytically, following a method based on a comparison with thermal plants, taking into account the annual water distribution, the storage volume, and the costs of construction of the hydro plant.

The third analytical paper comes from Russia and is entitled "Economic Grounds for the Availability of Hydro-Electric Station Capacity" by Dr. M. P. Feldman; it takes as its criterion the minimum of total production cost.

In one important paper the subject of hydro-electric resources is discussed from the wider viewpoint of power tendencies in Western Europe; it was contributed by Dott. Ing. C. Marcello of Societa Edison and is entitled "Tendances et Perspectives de la Production d'Energie Hydroelectrique dans l'Europe Occidentale." Dr. Marcello commences by quoting estimates of world resources. Known fuel resources of the world are considered to be equivalent to 27,000 million GWh and hydro-electric resources, based on average annual flows, are assessed at 4 million GWh per annum, whereas world annual consumption is expected to be 60 million GWh in 1975 and 160 million GWh in 2000. The last-mentioned figure is equivalent to roughly 1/200th of the known reserves, so that future prospects would be serious were it not for the development of nuclear energy, known resources of which are estimated to be equivalent to 182,000 million GWh.

The author then turns his attention to Western Europe, where it is estimated that by 1975 the production of electric power in the OEEC countries will be of the order of 1,300,000 GWh. A study of load curves shows that about 25% of the power produced is peak energy. According to latest estimates the hydro-electric resources that can be economically developed within the OEEC area amount to 533,000 GWh, and little more than one fourth of this had been developed by 1955. Some of this, of course, is run-of-river power and is therefore not available for peaking, but much of it is amenable to at least daily regulation. Even so, hydro power will not be sufficient to carry the whole of the peak load and it will have to be supplemented by thermal power, either directly or through the intermediary of pumped storage. The present trend in European hydro-electric practice, therefore, is to develop storage capacity to the utmost.

Pumped Storage and Development in Turbines

The growing necessity for pumped-storage schemes is the subject of many papers, some dealing with the economic aspect and others with the equipment being devised to meet an almost infinite number of different conditions. In their paper on "The

Economics and Design of the Blaenau Ffestiniog Pumped-Storage Scheme," E. S. Booth of the Central Electricity Generating Board and Geoffrey Kennedy of Kennedy & Donkin deal with both these aspects specifically as applied to Ffestiniog. Full details are given of the criteria on which the economic assessment is based, having in mind that the pumped-storage scheme has necessarily to be integrated into a generating system based predominantly on coal-fired stations. A comparison is made of the differential costs incurred with a hydro scheme and a new thermal station of equivalent capacity, estimates being given of the capital cost in each case and of the annual fixed and running costs of the two alternatives. The superior economics of the pumped-storage scheme are shown to be mainly due to the lower capital charges and also to the savings which accrue from the ability to replace coal-fired plant for emergency duty.

Reversible pump turbines were considered for this job, but although the capital cost was somewhat less than the conventional arrangement with separate pumps, it was thought that any saving would be offset by the less-efficient performance. Moreover some doubt was felt about adopting the pump-turbine arrangement at the present state of experience, especially in a major station operating on such a high head. The pipelines are designed for the full dynamic and pump shut-off heads of 1,325 ft.

Very full particulars are given of the topographical and geological features and special emphasis is given to the problems involved in the hydraulic design, both in regard to the aqueduct system, the dam intake, and the discharge phenomena in the lower reservoir.

Another paper dealing with the same subject, but referring to a plant on a very different scale, is that presented by M. Ward on "The Economics of the Ontario Hydro Pumped-Storage Project." Here a plant is being considered which, comparatively speaking, operates on a low head and has immense quantities of water available. The Niagara—an upper extension of the St. Lawrence—drains lakes Erie, Huron, Michigan and Superior into Lake Ontario, between which the difference in level amounts to 326 ft. Of this 160 ft. is concentrated at Niagara Falls, 50 ft. in the one-mile rapids section immediately above the Falls and 96 ft. in the rapids section, six miles long, below the Falls. The flow is remarkably regular, being equalised by the immense storage capacity of the upper lakes, which have a surface area of over 87,000 sq. miles. Roughly speaking the power potential outflow is divided equally between Canada and the United States, with the overriding provision that sufficient water should at all times be allowed to flow over the Falls to provide its famous scenic spectacle, especially during the hours of daylight in the holiday season. These conditions complicate the power generating problem and a further complication is involved by the rapid variations in flow which can take place as a result of wind effects, which cause the waters of the upper Great Lake system of pile up to cause increased spill over the Falls or to retard the spill by heaping up the waters away from the outflow. The variations can take place very suddenly and it was considered desirable to instal a pumped-storage system to assist in giving a more satisfactory overall result. The storage reservoir is really an extension of the forebay and has a capacity of 15,000 acre ft. The installation comprises six reversible pump-turbine units (Deriaz type) and this has enabled four 76.5 MW generating units to be added to the plant in the main Sir Adam Beck power house. It is estimated that the net annual savings amount to about $2.4 million per annum as compared with using thermal power to obtain similar results.

As is appropriate, the Deriaz pump/turbine runner is discussed by P. Deriaz himself, in conjunction with J. G. Warnock, also of the English Electric organisation. The title of their paper is "Economic Advantages of Variable Pitch Runners for Water Turbine Pumps." The Deriaz runner not only permits the head at which axial-flow pump/turbines (Kaplan type) can operate to be greatly increased but also allows the same favourable efficiency characteristics to be preserved. Furthermore, the inclined position of the blade axis permits a wide choice in the blade shape, balance and consequent general performance of the machine. Thus for operating at best efficiency, the discharge increases with increasing head and the pump is capable of a relatively greater discharge at the upper limits of the storage level than is possible from a conventional centrifugal pump. Much of the paper is devoted to the details of design, both in general terms and in special relation to the conditions which exist on the Niagara river. The paper leaves no doubt that this development, which represents one of the most important advances in design in recent years, will be of great assistance in forwarding the economic prospects of hydro-electric sites which are subject to wide variations in head and flow.

A further paper which considers the economics of pumped storage is that of J. Lavanchy of Winterthur. It is entitled "Simplification des Installations d'Accumulation Hydraulique a Hautes Pressions par l'Utilisation de Machines Reversibles." As will be gathered, high-head plants alone are considered and the pumping duty is undertaken by multi-stage centrifugal units. The author emphasises the growing importance that pumped-storage stations are assuming in the production of economic power, especially when they can be conveniently linked with a suitable distribution network. There is a need, he argues, to simplify these plants as much as possible and this has been done for the lower-head plants by the reversible pump/turbine runner. For the higher ranges of head, however, a multi-stage pumping unit is necessary and in the majority of cases will give very favourable results indeed. He stresses the need for each project to be carefully examined in detail if the most economical solution is to be found.

An interesting application of pumped storage is in process of development in the island of Majorca, and is discussed in a

paper "Utilisation Optima des Ressources Energetiques d'une Ile Pauvre en Combustibles" by J. M. de G. y Jacome and M. P. Fortuny. Majorca is a predominantly agricultural and touristic island with scanty power resources. The only indigenous fuel is lignite of very variable quality, and there is no sizable watercourse in the whole of the island. Nevertheless there is a mountain chain rising to 1,500 m. and although the rainfall at the feet of the mountains is very low the precipitation in the peaks rises to 1,000—1,500 mm. per annum. A series of high-level reservoirs is therefore being construct ed to feed a number of power stations, some of which will be of the pumped-storage type, the final discharge from these stations being used to the full for agriculture and domestic water supply. The highest storage will be afforded by Cuber reservoir at a level of 746 m. which will feed a pumped-storage stat on discharging to Aumedra reservoir at 288m. Two normal stations will be built below Aumedra. A second highlevel reservoir will be situated at Gorch (623 m) but to avoid loss of this water to the sea, as would occur if this head were developed directly, the whole of the make at Gorch will be pumped to Cuber reservoir. A third reservoir at Ofre (702 m.) and a fourth at Orient at a lower level of 433 m. will each feed an independent station. Finally a pumped-storage reservoir at a level of 635 m. is to be constructed to be supplied with sea water from an underground pumped-storage station.

Another important advance in design which has taken place in recent years refers to the reversible pump/turbine, which rotates in one direction but can be operated either as a turbine to produce power or as a pump to raise water to a higher level. This relatively new advance is discussed by W. J. Rheingans, Manager of the Hydraulic Department, Allis-Chalmers Manufacturing Company, in a paper entitled "New Developments in Design and Construction Hydraulic Turbines" in which reference is also made to improvements in other types of runner, either in their design or the methods used in their manufacture. The reversible pump/turbine combination makes a very compact unit that can be installed much more cheaply in the powerhouse structure, and has provided a distinct incentive to pumped-storage schemes where suitable heads are to be found. Reference is made to recent installations in the United States of America. Recent installations of four-jet impulse wheels at Kemano have revived interest in this type of runner which not only gives a very flat efficiency curve over a wide range of load but has the added advantage of being easy to maintain. Other advances in technique discussed by Mr. Rheingans include the fabrication of runners, spiral casings, stayrings, etc., by welding, and the extent to which rotary valves are replacing the butterfly and Johnson types of valve for flow control. He refers also to a dynamic balancer which the Allis-Chalmers concern have developed and which is stated to have a capacity of 250,000 lb.

Although the bulk of electrical energy (88%) in Czechoslovakia is generated by thermal means the remaining 12%, which is ginerated by water power, has proved to be invaluable in covering the highest peaks of the daily load, leaving the base load and the lower portion of the peaks to be met by thermal power, thus improving the overall economy of the system as a whole to a very substantial degree. The paper entitled "The Technical and Economic Aspects of Recent Development of Hydraulic Turbines in Czechoslovakia" by Ing. V. Kopecky deals with the situation in that country in admirable detail. The fact that the hydraulic turbines may be required to deliver maximum output when working on minimum head, in order that the "guaranteed output" may be maintained, has led the Czechoslovakian authorities to give special attention to designing turbines with high efficiencies over a wide range of loads and to have them in absolute readiness when they are required to take over. A number of Kaplan turbines have been installed in recent years ranging from 8 to 23 MW per unit at flows of between 70 to 130 cu. m. per sec. Bulb-type designs, having efficiencies of 93%, are now used for low heads and are entirely replacing geared units. Satisfactory operation has been experienced with Kaplan machines working on heads of 50 to 70 m. but care has to be taken against cavitation, due to heavy turbulence under certain parts of the blades and to gap cavitation. Built-up welding is used against cavitation and the guide blades are rubber sealed. An inductive pick up is used for controlling the oil film for the main suspension bearing, and another interesting feature is that an electrical braking system has been devised. Automatic operation has been widely introduced with the result that the economy and readiness of the hydro plants have been promoted to a very high degree. Work is being done on diagonal-flow turbines.

Tubular turbines are gradually increasing in number and have enabled power sites to be exploited that would not have been considered economic with a normally arranged hydro-electric plant. As stated in his paper "Development of the Tubular Turbine with Reference to Economical Production of Hydro-Electric Power" A. Pfenninger, of Escher Wyss Ltd., speaks of the great amount of research work that has been done in recent years to reduce the weight of bulb and tubular units and increase their efficiency. These types of units open up entirely new prospects for low-head falls and power from the tides. Mr. Pfenninger traces the development of the tubular turbine since its first introduction in 1936. Efficiencies have been substantially increased and the newer arrangements show definite advantages compared with the earlier machines. These factors have greatly increased the range of conditions to which the units can be applied. Indeed, the design work may now be said to be finalised, and what is required now is that engineers should have a clearer understanding of the value of these units and a better appreciation of the conditions in which they can produce well-worthwhile blocks of power. No less than 70 Escher Wyss machines are now in opera-

tion on the Lech and Iller in Germany alone.

Water-turbine production in Yugoslavia is treated in a paper "L' Histoire de la Production des Turbines Hydrauliques en Yougoslavie" by Prof. Ing. A. Struna. The author sketches the history of water power in Yugoslavia, extending well over 100 years, and describes the great advances in water-turbine construction in his country during the past ten years. The potential hydro-electric capacity in Yugoslavia is estimated at a theoretical figure of 66,000 GWh per annum, of which 50,00 GWh may be amenable to practical development.

Tidal power is discussed in a paper "Problemes Economiques Poses par l'Exploitation Optimum d'une Usine Maremotrice" by R. Gibrat of Electricite de France. M. Gibrat is a well-known authority on tidal power. His World Power Conference paper follows somewhat similar lines, but is to be warmly recommended as a brilliant exposition of the principles of tidal-power development with the aid of the axial-flow turbine/sluice valve/pump machine which the French have been developing for this purpose. In the latter part of his paper the author examines the economic possibilities of the Rance scheme.

Electrical Transmission

In the section dea'ing with electrical transmission several papers are concerned specifically with transmission in hydro-electric systems. An interesting ana'ysis of the problem as it obtains in Brazil is to be found in a paper "Some Economic Considerations of Long Distance Electric Power Transmission in Brazi." by A. W. Huseby. Brazil has hitherto been a predominantly agricultural country but is rapidly developing industrially at certain well-defined load centres. Its power resources, which are abundant, are almost entirely hydro-electric, and are so situated that long-distance transmission will form an essential part of the pattern of supply. Initially lines will have to be built 300 to 500 km. long, and later up to 800 km.

Certain special problems arise in planning a transmission system in a developing country such as Brazil. The route of a transmission line between a hydro plant and its load centre must be selected with an eye to the future development of the intervening country. Again, a line will be related essentially to a particular hydro plant and will not, as in highly developed countries, form a tie between two centres each of which has generating capacity and a demand or load. Thus the evaluation of line losses—and consequently the choice of conductor sizes—becomes both important and complex, and will be influenced by the hydrological characteristics and storage facilities at the power site. A further difficulty is that of predicting future load ; for example, the growth of a load centre near the power site might completely upset the economics of a transmission line. The author illustrates this last point by a numerical example in which he compares the costs of alternative lines of 1,000 MW capacity at 230 kV and 345 kV respectively, and shows how the growth of a demand of 230 MW near the station would entirely change the economic balance.

In connection with the Bersimis development in Quebec a comparative cost study was made for transmitting 800 MW a distance of 387 miles at four alternative voltages—230, 287, 345 and 380 kV. The conditions to be met and the results of the study are summarised in a paper "Economics of Transmission from Bersimis River Developments" by D. M. Farnham J. R. Hango. It was concluded that transmission capacity would be provided with double-circuit lines at 287 kV at less cost and with greater reliability than with single-circuit lines at higher voltages.

The design of transmission lines in Finland is discussed in a paper "Economic Aspects of the Construction of the High Voltage Transmission Lines in Finland" by L. Haro and B. Magnusson. Seeing that two-thirds of Finland's water-power resources are in the northern part of the country whereas the population and industrial concentrations are in the centre and south, long transmission lines will be inevitable, and their construction must be carefully studied to reduce their costs to the minimum consistent with safety. Mechanical safety is considered to be of more practical importance than electrical safety, and a study has been made of wind loading, ice loading, and loads caused by conductor breakage, with a view to combining a low factor of safety with avoidance of risk. Electrical earthing conditions are very difficult in Finland, and a study is made of the economic value of earthing wires for conductor protection. A description is given of a guyed portal tower which is stated to possess marked advantages in cost, performance, and erection facilities in comparison with the normal self-supported tower.

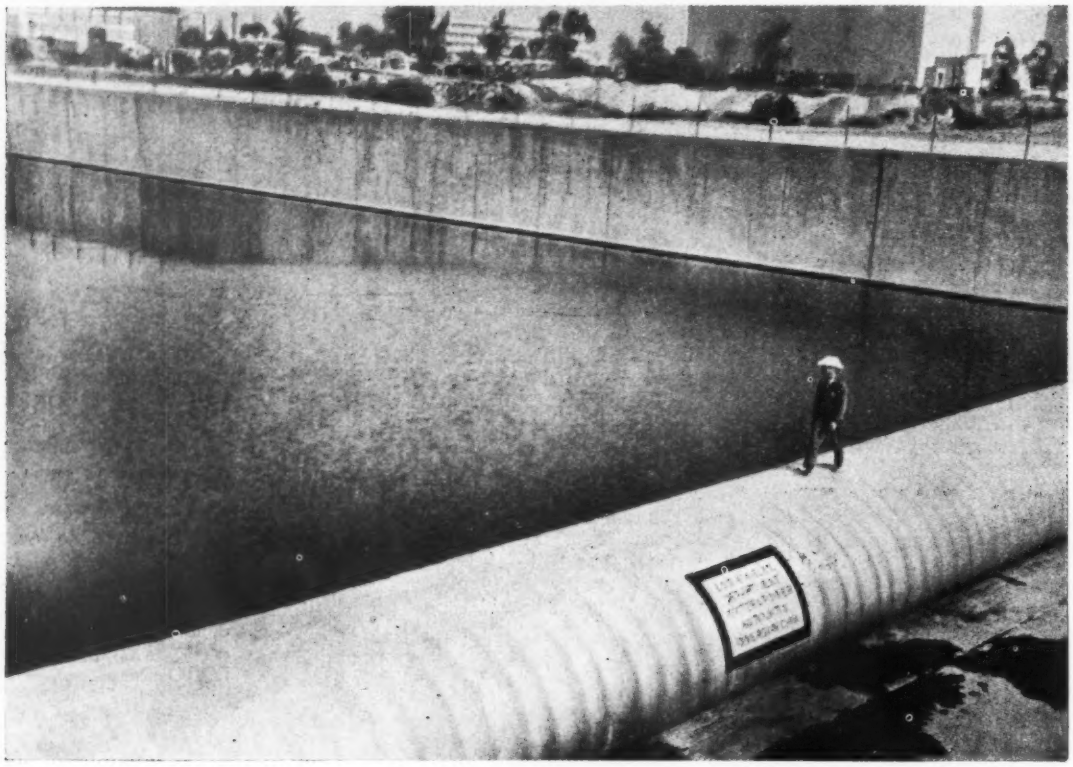
Collapsible Dam

Most dams are built to control floods and store water, but the Firestone Tire & Rubber Company has manufactured and installed in the Los Angeles River an unusual structure designed to be collapsed at the first indication of flood danger.

This unique dam—a giant nylon bag coated with neoprene—was developed to serve dual requirements of the Los Angeles Department of Water and Power in providing the city with water and of the U.S. Army Engineers in protecting the city against floods.

For many years, the department had maintained a wooden dam at this location to divert Los Angeles river water into nearby basins, where it seeped into the ground, raising the water table. The water was later recovered by pumping.

During winter months, when flood danger is imminent, the dam had to be removed to prevent the



The Nylon Dam

river water backing up and overflowing its banks. During this period, the flow could not be diverted, resulting in the loss of valuable water which ran off into the Pacific Ocean.

The Firestone dam can be left in place the year around. It can be collapsed in 10 minutes should flood danger arise. As soon as a flood recedes, the giant bag, which is 150 feet long and 8 feet in diameter, can be inflated again by pumping water into it.

It takes about 25 minutes and 50,000 gallons of water to inflate it to its maximum height of eight feet.

So huge is the dam that it had to be constructed in sections. No machinery exists which is large enough to vulcanize such a giant piece of rubberized fabric.

Firestone made the dam in 30-foot sections which were later cemented together to form one enormous piece. Loxite, an adhesive developed by the rubber company to patch rubber life rafts, was used to cement the sections together.

Constructed of two plies of nylon fabric coated with a heavy "skin" of neoprene, the dam is bolted to the cement bottom and retaining walls of the river. It is similar in construction to the well-known Fabritank by Firestone, nicknamed the "Whale."

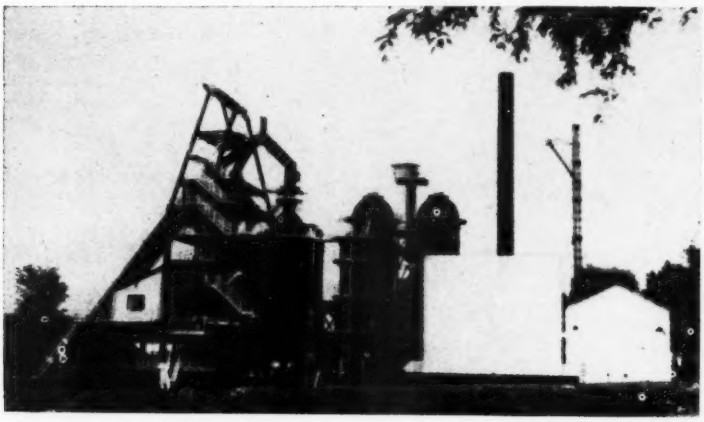
Fabritanks are becoming increasingly popular, particularly in the petroleum industry, where they are replacing bulky metal tanks which are difficult to transport to remote drilling locations. According to L. J. Campbell, vice-president, Firestone's pioneering of fabric tanks helped make possible the giant Los Angeles dam.

Now that the practicality of the dam has been determined, it is expected that other installations will be made in the area. The Department of Water and Power estimates that some 3,000 acre-feet of water valued at $75,000 can be conserved annually.

India's First Low Shaft Furnace

Situated in a valley at the Barbil in the District of Keonjhar, Orissa, surrounded by iron-deposit hills, the construction of this first low shaft furnance was completed within a record time of 18 months.

Designed by M/s. Fried. Krupp of Essen, West Germany, employing the Koppenberg Wenzel process, 50 percent of the plant was manufactured in India under supervision of Indian Engineers. The erection was also done under supervision of Indian Engineers. The



A view of the India's first Low-Shaft Furnace

commissioning of the furnace was done entirely by our engineers without any foreign assistance.

The furnace has a capacity of 120 to 150 tons of pig iron per day. Ore size 10 to 40 mm. which cannot be used in any large quantity in conventional blast furnaces, nor can be exported and thus becomes a national waste, is the principal raw material for this plant. Experiments are under way to use ore fines which are lying in large dumps at pit mouths.

Nut coke which cannot be used in blast furnace more than 5 percent is used as fuel in this furnace. It has been established elsewhere that such furnace can be operated with poor quality coke or coke out of lignite and in due course such experiments on commercial scale will be carried out in this furnance.

After observing the performance of this furnance for 2 days, the technical adviser of the Kalinga Industries is convinced that any grade of pig iron can be produced in this furnace.

Such plants have a great future in India as well as Asian countires where good quality metallurgical coke is not avai able easily. Sardar Swaran Singh, Minister for Steel, Mines and Fuels indicated the Government's policy the other day that such furnances could be erected all over the country for supply of pig iron to foundries.

Such plants can go up all over the country without any drain on our national foreign exchange resources. Production of iron can be decentralised and transport bottlenecks obviated, thereby assuring timely and regular supplies to the consuming points all over the country without unduly loading our already strained Railway capacity.

Huhn Carbon Ring Seals for Hydraulic Turbines

The Huhn company are specialists in the industrial sealing field with 60 years experience. Seals are their only business and very considerable research and development work over the years have enabled Huhn products to be highly successful in countries all over the world.

The different types of Huhn Seals to be installed to Hydraulic Turbines are: Huhnbox, Fahturbox, Hydrobox, Boltbox, and Mantlebox. The type to be chosen depends on kind and size of turbine and fall height to be sealed.

Construction Features

With the exception of type 4. Boltbox all Huhn seals are enclosed by a compact housing in which the sealing ring assemblies are placed.

Depending on the height of the water pressure, which has to be sealed 2, 3 or 4 sealing ring assemblies are provided. An absolute 100% sealing is undesirable. A small leakage, depending upon water pressure, diameter of seal and vibration of shaft is recommended. The small amount of leakage water provides a water film between the carbon rings and the shaft surface. This water film constitutes a lubrication and prevents friction.

Sealing Elements

The sealing ring assembly consists of a multi-part carbon ring, precision tapered at its circumference. A correspondingly tapered pressure ring is provided around the carbon ring sections held together by along garter apring. This garter spring holds the sections of the pressure ring and the carbon ring in position.

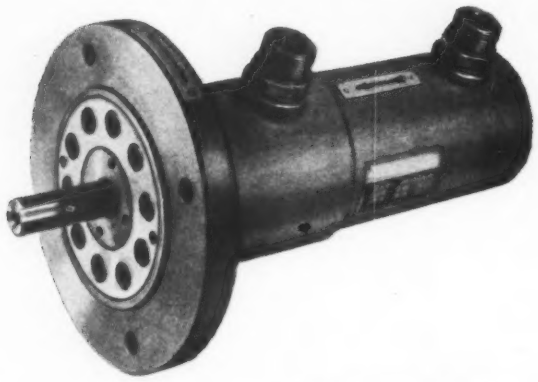
Inlet of Sealing Water

This method is replacing the filter grease. With the large turbines usually found in modern installations, clean stop water is always available. In order to prevent the sealing water from disappearing ineffectually downwards, Huhn equip the bottom plate with the labyrinth, supplied as a so-called labyrinth ring.

Best results have been achieved by using centrifugally cast bronze sleeves. Several customers are using stainless steel on the shaft surface.

The carbon rings of the Huhn sealing boxes have an average durabi ity of 8 years, provided that the water which has access to the rings is clean.

Backed by the very extensive experience in the design of their seals, the selection of the materia's of the component parts and their relation to each other, Huhn carbon rings carry a guarantese of 3 years and all other parts of 5 years, provided that the water, which has access to the seals is clean.



Screw Pumps

Outstanding features of the latest Hungarian screw pumps are high efficiency, durability, safe operation, reasonable measurements, and uniform delivery. Versatile indeed these pumps are serviceable with any kind of hydraulic machine or equipment such as machine-tools, vehicles, steam and water turbines, hoisting engines, etc. Various sizes and types of screw pumps are being produced by the Hungarian industry, with a maximum pressure of 10-175 atm and a discharge of 2-400 litre/min. The screw pumps operating in any position are made with flange and foot to facilitate installation. For materials to be delivered at high temperatures only, such as black oil, grease etc. special pumps with heating jacket are available.

Screw pumps of Hungarian make are equipped with coarse-pitch screw spindles i. e. a lead screw spindle flanked by two sealing screw spindles. The liquid between the threads is enclosed within the space limited by the screws and their sleeve and displaced with the rotation of the screw spindles. Up to 4-6 m screw pumps are self-priming. Exporters Technoimpex.

The World's Most Powerful Turbine

The Central Electricity Generating Board of the U. K. are placing an order for two turbine generators each of 300,000 kW capacity with the A. E. I. Company. The order includes the condensing plant and feed water heating plant as well as the various auxiliaries associated with this equipment, the value of the order being about £5,000,000. The machines are to be installed in a Power Station which will be located at West Thurrock near Tilbury. This Power Station has a planned capacity of 1,000 MW and when in full operation the coal consumption will be in the order of three and a quarter million tons per year. This contract constitutes an outstanding development since it is the world's largest turbine-generator unit producing all the output in one single line machine at 3000 r. p. m.

Readers may have seen reference to generating units of larger capacity which are already in manufacture, but these units produce the output by dividing it between two single line machines which work together on the same steam circuit and generate the electrical output by two generators in parallel. In such units therefore the output of each turbine generator is about half of the total output of the whole unit.

It is a remarkable fact that this turbine generator of 300-MW capacity is about equal in size to those which were produced a decade ago, but gave only a fraction of the output.

As a measure of the advance in generating efficiency, it may be noted that in the twelve months ending 31st March 1922, the 396 steam Power Stations in Great Britain generated 4,733 million units of electricity and consumed just over 6½ million tons of coal. The two new machines alone will be capable of generating 5,256 million units in a year, and their boilers will consume about two million tons of coal.

These machines will incorporate a number of advanced design features.

One of these is the water cooling of the generator stator; which enables the maximum electrical output to be derived from a given dimension of machine. A. E. I. were the world's first to successfully experiment with water cooled stators, one machine having been in commercial operation since 1956 with at over 99% availability.

In this cooling system the water is in direct contact with the copper; passing through hollow conductors. The insulation of the system depends on the fact that the water, if sufficiently pure, has a resistivity high enough to serve as an insulator.

The cooling of the generator rotor is by means of hydrogen at 30 p. s. i. g. pressure by means of latest method of direct-cooling i. e., where the hydrogen gas in in direct contact with the copper conductors.

These various design features make it possible to keep the weight and dimensions of the alternator stator within the limit of transport facilities available in the U. K. For the purpose of transport the generator and bells can be removed together with the hydrogen coolers.

The generation is at 16,500 volts, 0.85 power factor, 3 phase, 50 cycles.

Another feature which is associated with present day large generating units is reheating of the steam, again in this field A. E. I. were the first to introduce reheating commercially as early as 1917 at North Tees Power Station. It is natural that A. E. I.

should also be entrusted with the order for the feed water heating system for this generating plant, since here again A. E. I. were the first to carry out a thorough investigation of the practicable possibilities of various methods of feed heating; a system of turbine feed heating which represented a substantial advance on anything done previously was patented by by A. E. I. in 1915.

The turbine generator will operate with a steam inlet pressure of 2300-p. s. i. g. and a temperature of 1050°F. After the steam from the boiler is expanded through the first high pressure stages, it is passed back to the boiler where it is reheated again to 1050°F.

The reheated steam is then passed to the intermediate pressure cylinder from which it is conducted through overhead pipes to the two double flow low pressure cylinders.

The turbine comprises four cylinders which are all in line directly coupled and driving the generator. The four turbine cylinders and generator therefore form one single rotating unit. The exciter is driven through gearing from the end of the generator shaft.

Cooling water for the steam condensers, which is required in large quantities for a machine of this size, will be taken from the Thames estuary.

It may be said that this achievement of producing the most powerful generator has also been made possible by very advanced methods of quality control in the construction of turbine generators. It will be realised that the parts subject to the highest mechanical stresses are the turbine and generator rotors. These rotors are machined out of special forgings, and subjected to very careful tests. In this field again A. E. I. were the first to introduce the method of trepanning a core piece out of the rotors to enable tests to be carried out on material representative of the centre of the forging. The first effective system of checking rotors for hair cracks was also introduced by A. E. I.

Prime Minister opens Kamani Community Centre

On the 4th October, 1959 the Prime Minister of India visited the premises of the Kamani Group of Industries at Bombay to lay the foundation stone of the "Kamani Community Centre" meant for recreation, education and welfare of the community which comprises of many industrial workers. He also received a handsome purse of Rs. 1,00,001/- made up of spontaneous contribution from the workers, staff and the management. A silver replica of Transmission Line Tower was also presented to the Prime Minister in commemoration of the Kamani Engineering Corpn. Ltd. having reached the production of 51,000 tons of Transmission Line Towers.

Shri Y. B. Chavan, Chief Minister of Bombay State presided over the function attended by over 4,000 people,

The Prime Minister was taken round all the three factories and various operations were explained to him by the Managing Director Shri P. R. Kamani.

Shri Nehru showed special interest in the Non-ferrous Exhibition, the Galvanising Plant and the novel 'Tractamount' Road Roller deriving its motive power from a tractor mounted on it. He also was pleased to learn about the export promotion efforts made by Kamanis.

Shri R. H. Kamani, Chairman of the Board of Directors briefly reviewed the progress of these factories from a humble but pioneering effort in 1939 in Non-ferrous Metals. Subsequently various production lines were added. During the war, difficult, specialised items like Arsenical Copper Rods, Cupro Nickel Strips, White Metals, Naval Brass, Leaded Brass, Muntz Metal etc. were manufactured for defence organisations. Later on, Copper and Cadmium Copper Conductors and Rods, Brass Rods, Sheets, Strips in coils, Transmission Line Towers, House Service Meters, Zinc Oxide and Tractamount Road Rollers were added.

They have secured very recently technical collaboration with Messrs. Siemens, the world renowned Electrical Engineering firm of West Germany, for a new type of House Service Meters.

They are the pioneers in the manufacture of (*i*) Arsenical Copper Rods (*ii*) Transmission Line Towers (*iii*) Cadmium Copper Rods and conductors (*iv*) House Service Meters (*v*) Tractamount Road Rollers.

Shri Kamani said that this was the first and only factory having facilities for Designing, Fabricating, Testing, Galvanising and erecting Transmission Line Towers all by cent percent Indian Technicians.

They had been able to secure technical co-operation from Japan, Germany, U. K. New Zealand and Belgium for House Service Meters, Tractamount Road Rollers, Pigments and handling Railway Electrification Projects respectively.

Sri Nehru opening the Kamani Community Centre at Bombay

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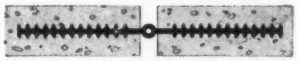

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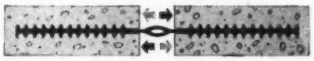

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Our Contributors

Mr. M. Hayath graduated in Engineering from the University of Mysore in 1923. He joined the Mysore Public Works Department in 1924. Deputed by the Government of Mysore for Foreign Training from 1927 to 1930 he obtained the B. S. E. E. degree from the Union University, Schenectady, New York. From 1941 to 1953 he was Chief Electrical Engineer to the Government of Mysore. He served as Power Consultant to ECAFE at Bangkok for 14 months in 1951-52. After retiring from the Mysore service, he joined the ECAFE again in January 1953 as Cheif of Power Division. He returned from Bangkok in 1954 and joined the Central Water and Power Commission as Member (Hydro-Electric). He is at present Chairman of the Cantral Water and Power Commission.

Mr. S. S. Kumar graduated in 1922 from Government College, Lahore, Punjab University. He received his M. Sc. in Physics in 1924 standing 1st in the University. He graduated in 1927 from City and Guilds Civil Engineering (A. C. G. I) and obtained Postgraduate Diploma in Hydro-Electric Engineering from Imperial College (D. I. C.) in 1928. He secured B. Sc. Hons. (Engineering) London in 1927 and M. Sc. (Engineering) London in 1929.

After obtaining practical experience in the Shannon Hydro-Electric Scheme in Ireland, joined the Punjab P. W. D. Electricity Branch in 1934. Became Project Engineer there in 1944 by selection through Public Service Commission and was deputed to U. S. A. for 9 months in 1946 to gain experience in latest design and construction practices in hydroelectric generation and transmission of power etc. On return planned and designed the Rasul Hydro-Electric Project (now in West Pakistan) and the power portion of the Bhakra Nangal multipurpose project. Promoted as Chief Engineer and Electricity Secretary to the Government, Punjab P. W. D. on first April 1948 and after completing the construction and commissioning of the Nangal Power Projects came on deputation in May 1955 to the Central Water and Power Commission, as Member (Utilisation). Led the Indian Delegation in 1956 on three months Group Study Tour of Electrical Engineering Experts of ECAFE Region to U. S. S. R. Sweden, U. K. France, West Germany, Czechoslovakia, U. S. A. and Japan.

Mr. Yadav Mohan I.S.E., Member (Plan and Investigation) CW & PC. An honours graduate of the Thomason College of Civil Engineering, Roorkee, Mr. Yadav Mohan was selected to the Indian Service of Engineers in 1929. In the course of his extensive service in U. P. he has been associated with the construction of hydroelectric and steam power station and tube-wells. He has also worked on the Upper and Lower Ganga canals. Was responsible for major extensions to the Sarda Canal system, and was also employed on the construction of a number of earth dams and canal systems in the Bundelkhand area of U. P. The investigations and project proposals of the largest hydro-power scheme in the State-Rihand Project were conducted by him. A long range master plan for irrigation and power development in U. P. was prepared by Mr. Yadav Mohan in his capacity as Member-Secretary of a Committee specially created for the purpose.

As Chief of the Natural Resources Division of the Planning Commission during 1953-58, he was one of the chief architects of the Second Five Year Plan for irrigation and power development in India.

Mr. Yadav Mohan represented the Government of India in 1957 as a delegate to the third Congress of the International Commission on Irrigation and Drainage in California. At the same session, he was appointed the Secretary-General of the International Commission. In this capacity he convened in 1958 an International Seminar on Irrigation and Drainage and Flood Control in Czechoslovakia and conducted the ninth meeting of the International Commission on Irrigation and Drainage in Italy.

Dr. R. C. Hoon, M. Sc., Ph. D., is Director of the Silt and Construction Materials Directorate, Central Water and Power Commission, New Delhi, since December, 1954. Formerly, he was incharge of the Hirakud Research Station, Hirakud Dam Project, Orissa State.

Mr. R. D. Dhir I. S. E. after qualifying from the Thomason Engineering College, Roorkee, in the year 1929 joined the Sind P.W.D. as ISE student and rose to the rank of Chief Engineer in 1956. Has travelled extensively in Middle East and Europe. Member of various consultative Commissions both Indian and International. Author of various technical books and papers. Specialist on Irrigation, Hydrology and Flood Control. At present in charge of Flood Control on the Planning and Design side in Central Water and Power Commission.

Mr. P. R. Ahuja graduated in Civil Engineering from London University and also secured the A. C. G. I. in 1934. In 1950 he was elected as a full Member of the Institution of Engineers (India). Ahuja has had varied experience with structural firms in England and India, and later with the Punjab Irrigation Department. During the war he was with the Army. Associated with the Central Board of Irrigation and Power and the Central Water and Power Commission from 1947. Represented India at the International Executive Council meeting of the International Commission of Large Dams and the World Power Conference in Belgium in 1949. In 1951 he took an active part in the International Commission on Large Dams, World Power Conference, International Commission on Irrigation and Drainage and the Engineering exhibition held in New Delhi.

In September, 1954 he attended the Working Group of Experts on Hydrological Terminology and Deficiencies in Hydrological Data for the ECAFE region. Again in September, 1956 he attended the Flood Symposium held at Djion (France). Delivering lectures both at the Refresher Course and Water Resources Development Centre at Roorkee University on hydrological aspects. Also delivered lectures at the FAO Development Centre on Watershed Management in Hazaribagh. At present Director, Hydrology and Statistics in CW & PC.

Mr. S. Raghavachari graduated from the Madras Engineering College in 1927. Served in the Madras Irrigation Department, and the Hirakud Dam Project before joining the Commission. Was also actively connected with the design and planning of various projects in the former composite State of Madras.

Mr. Raghavachari is at present Superintending Engineer in the Canals Directorate of the CW & PC.

Mr. V. Venugopalan took his B. A. (Hons) Degree of the Madras University in 1929 and obtained the Certificate of Proficiency in Electrical Technology from the Indian Institute of Science, Bangalore, in 1933. He joined the Madras Govt. Electricity Department in 1934 and worked in various capacities till 1947, when he joined the Government of India as Project Officer in the last Central Technical Power Board. He is now Director (Transmission) in the Central Water and Power Commission (Power Wing).

Mr. K. C. Khatri After taking B. Sc. degree from the University of Punjab in 1928, joined the University of London for the B. Sc. Eng. degree, which he obtained in 1932. Also passed A. C. G. I. from the Imperial College of Science and Technology (City and Guilds Engineering College), London in the same year. Joined service under the N. W. F. P. Public Works Department in 1934 and rose to the rank of Deputy Secretary when due to partition of the country came over to India and joined the CW&PC in 1947. He is at present working as Director in Charge of the Directorate of Administration and Coordination in the CW&PC.

Mr. K. B. Khushalni graduated in engineering from Bombay University in 1929 in first class. He was associated with the construction of the Lloyd Barrage proper and its canals; later was in charge of its regulation and maintenance. He carried out various important works including one of diverting river Indus to save Mithiani town. He also worked on Chhiter Palace construction, Jodhpur. His services were lent to Government of Punjab for organising Civil Engineering graduate classes in the Punjab College of Engineering, Lahore. His services were also borrowed by NED Engineering College Karachi twice.

After partition Mr. Khushalani joined the Central Water and Power Commission where he has been working in various fields. Last three years he has been engaged on examination of projects of First and Second Five Year Plans.

In 1958 Mr. Khushalani went on Study Tour of USA and Europe sponsored by ECAFE and UNTAA as sole Indian delegate among experts of Asia and the Far East.

Mr. Khushalani has written a treatise on Irrigation in seven volumes and has to his credit several original research work and other books and many papers. He is at present Director, Technical Examination in the CW&PC.

Mr. A. P. Seethapathy graduated in Electrical Engineering from the Madras University in 1934. Passed with Honours and was placed first. He also got the Diploma in Electrical Engineering from the College of Engineering, Madras, in 1934. Was awarded Gold Medals and prizes.

He joined the Madras Government Electricity Department in 1937. Served the Department in various capacities till early 1953, when his services were placed at the disposal of Govt. Electricity Department, Bihar. He served Bihar Government till August, 1956. He joined the Central Water and Power Commission in August, 1956 as Director (Rural Electrification), to which post he was selected by the U. P. S. C.

Dr. S. L. Banerjee obtained his Doctorate degree in Physics from Dacca University in 1938. He studied Geophysics, as a Government of India Scholar, in Columbia University New York and in Carnegie Institution, Washington during 1946-47. He worked in Geological Survey of India during 1948-50 as an Assistant Geophysicist and the results of his geophysical exploration in Bombay area is recognised as having first drawn attention to that area as possessing underground structure favourable for accumulation oil.

Since 1950 he has been a Geophysicist in Central Water and Power Research Station, Poona, and has been responsible for many Geophysical investigations connected with River Valley Development Projects.

Mr. A. Shankaran is Director of "Load Survey and Load Development Directorate" in the Central Water and Power Commission. After graduating in Electrical Engineering from the Bombay University in 1939, Mr. Shankaran began his career as an Assistant Electrical Engineer in the Sholapur Mills. In 1943 he joined as an Asstt. Director in the Directorate General (Supply) New Delhi, from where he was transferred to the Electrical Commissioner's Office Calcutta (now the C.W. & P.C. Power Wing) in 1945. In 1949 he went over to the Hirakud Dam Project then in its inception, remaining with that organisation until the middle of 1958, during which period he served initially as an Assistant Executive Engineer and later as Executive Engineer, being associated with almost all phases of construction on the electrical side of the Project including the 132/66 kV Transmission Lines and the Hydro Power House of the Hirakud Power System. His services were placed back at the disposal of the CW & PC in August, 1958.

Mr. J. E. Vaz born in Mysore State in 1915, Mr. Vaz received his education at St. Aloysius College, Bangalore, and the College of Engineering, Madras.

He first joined Government service in 1940, as an Assistant Engineer in Madras Service of Engineers. He was promoted as Executive Engineer in 1946 and Superintending Engineer in Madras Public Works Department in 1955. He was selected for the post of Director (Plant and Machinery), Central Water and Power Commission, by the Union Public Service Commission, which post he is holding since January, 1958.

Mr. Vaz has been on study tour in U.S.A. for one year during 1948-49.

Dr. K. C. Majumdar was a brilliant student of the university of Calcutta. After graduation with Honours in Physics, he joined the Indian Meteorological Department in 1943. While in service, he obtained first class Master's Degree in Statistics in 1952 and was admitted to the Degree of Doctor of Philosphy (Science) in 1956. Soon after the completion of his thesis for D. Phil degree, he joined the Central Water and Power Commission as Assistant Director (Statistics) in the beginning of 1957.

Dr. Majumdar has wide experience in many branches of applied science. He has published several valuable papers on the Theory and Application of Statistics in high polymer science, Meteorology, Hydrology and Hydrometeorology.

INDEX TO ADVERTISERS

	Page
Aluminium Industries Ltd.	32*b*
ARBED (Columeta), Luxemburg	xv
Associated Electrical Industries (I) Private Ltd.	i
Batliboi & Co.	xxxiii
Bird & Co. (Private) Ltd.	x
Blackwood Hodge (India) Private Ltd.	12
Blue Star Engineering Co. (Bom.) Pvt. Ltd.	xx
Boydell, E. & Co. Ltd., England	xix
British Insulated Callender's Cable Ltd.	28*a*
Burmah-Shell Oil Storage & Dist. Co. of India Ltd.	xi
Carborundum Universals Ltd.	21
Cementation Co. Ltd., The	xxix
Cement Research Corporation	50
Charmilles Engineering Works Ltd., Geneva	v
Crompton Engineering Co. (Madras) Ltd.	xxiii
Dominion Engineering Co. Ltd., Canada	xviii
Dunlop Rubber Co. (India) Ltd.	16*a*
Eastern Equipment & Sales Ltd.	2*a*
Electrical Machines Corporation Ltd.	4*a*
Elektromekano, Sweden	28*b*
English Electric Co. Ltd.	xlvi
Escorts (Agents) Ltd.	Second cover
Finmeccanica Group of Industries, Italy	ii
George Fischer Ltd.	xiii
Giovanola, Switzerland	xvii
Goodyear Tyre & Rubber Co. of India Ltd.	22
Greaves Cotton & Co. Ltd.	4*b*
Gustav Huhn, Sweden	vii
Indian Cable Co. Ltd.	xxxi
Indian Hume Pipe Co. Ltd.	xxxii
Indian Steelworks Construction Co. Ltd.	viii
Industrial Gases Ltd.	xxxiv
Industrial & Agricultural Engineering Co. (Bombay) Ltd.	32*a*
Jenson & Nicholson (India) Ltd.	8*a*
Jyoti Calor-Emag Ltd.	xxvi
Kirloskar Brothers Ltd.	16*b*
Larsen & Toubro Ltd.	2*b*
Marion Power Shovel Co. U.S.A.	xxvi
Martin Burn Ltd.	16*b*
Micanite & Insulators Co. Ltd., The	62
Motwane Private Ltd.	iv
National Electrical Industries Ltd.	vi
National Insulated Cable Co. of India Ltd.	62
National Carbon Co. (India) Ltd.	xxii
Parry & Co. Ltd.	xxiv
Pegson Ltd., England	xxv
Reyrolle, A. & Co. Ltd.	xlii
S. A. E. (India) Ltd.	xxxvi
Scarpa & Magnano, Italy	x
Siemens Engineering & Mfg. Co. of Inida Pte. Ltd.	Back cover
Skoda (India) Private Ltd.	xxviii
Structural Waterproofing Co. (Private) Ltd.	50
Telegraph Construction & Maintenance Co. Ltd., England	8*b*
Technoimpex, Hungary	xxx
Tokyo Shibaura Electric Co. Ltd., Japan	Third cover
Timken made in U.S.A.	iii
Tractors (India) Ltd.	xvi & 34*b*
U.S.S.R., Trade Representation in India of	xii
Voith J. M. Germany	vi
Voltas Ltd.	ix & 34*a*
West Bengal Government	44
Westinghouse Trading Co. (Asia) Ltd.	xiv
William Jacks & Co. Ltd.	xxi

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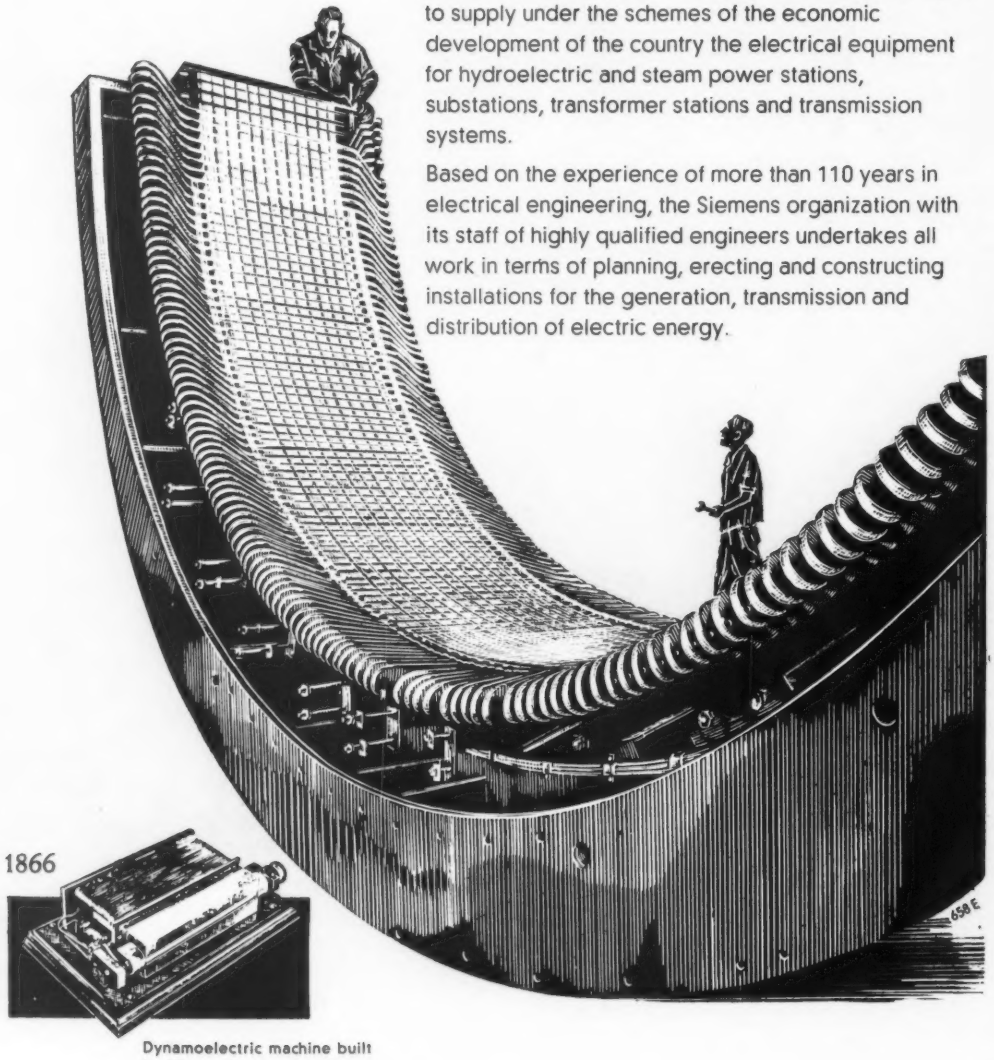

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